

5100 Series

DIGITAL/ANALOG PORTABLE RADIO

SERVICE MANUAL

5100 SERIES PORTABLE RADIO

- APCO Project 25
 - Conventional
 - Trunked
- SMARTNET®/
SmartZone®
- Analog FM
Conventional

VHF 1 and 5 Watts

UHF 1 and 4 Watts

700 MHz 1 and 2.7 Watts

800 MHz 1 and 3 Watts

7.2 VDC

Part No. 242-51xx-xxx



Part Number: 001-5100-0017CD

December 2004

Supersedes: 001-5100-0016CD; 8/04



51xx SERIES PORTABLE

VHF, UHF, 700/800, 800 MHz

**PROJECT 25 CONVENTIONAL AND TRUNKED
ANALOG CONVENTIONAL
SMARTNET[®]/SMARTZONE[®]**

7.5 VDC

5W (VHF), 4W (UHF), 2.5W (700 MHz) 3W (800 MHz)

Part No. 242-51xx-xx0

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Information in this manual is subject to change without notice.

Covers Firmware Versions: 5100 1.12.1/2.2.1/3.2.1/PCConfigure 1.25.0

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SECTION 1 GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains operation, programming, alignment, and service information for the EFJohnson 5100 series portable radio.

The 51SL and Ascend (Multi-Net) models are similar in appearance and covered by separate manuals as follows:

51SL Portable Serv Man - P.N. 001-5200-0010CD
Ascend Portable Serv Man - P.N. 001-5584-0010CD

The distinguishing characteristics of the 5100, 51SL, and Ascend models are as follows:

5100 Series Portable

- Part No. 242-51xx-xxx (see Section 1.4)
- EFJohnson logo under display
- Black front bezel with black keypad keys

51SL Series Portable

- Part No. 242-52xx-xxx (see Section 1.4)
- “51SL” label under display
- Grey front panel bezel with white keypad buttons

Ascend Series Portable

- Part No. 242-558x-xxx (see Section 1.4)
- “ASCEND” label under display
- Black front panel bezel with black keypad buttons

1.2 RADIO DESCRIPTION

1.2.1 GENERAL

The 5100-series portable transceivers have multiple system programming capability to allow operation in various types of radio systems as described in the information which follows.

Models are available for operation in the following frequency ranges. Repeater talk-around, which allows transmitting on the receive frequency, is also available with all bands.

VHF: 136-174 MHz

UHF Low: 380-450 MHz (Federal Users Only)

UHF Mid: 403-470 MHz

UHF High: 450-512 MHz

700/800 MHz: 762-806 and 806-870 MHz

800 MHz: 806-870 MHz (see next section)

Power output is user switchable for low and high levels as follows:

VHF - 1 and 5 watts

UHF - 1 and 4 watts

700 MHz - 1 and 2.5 watts

800 MHz - 1 and 3 watts

1.2.2 NEW 700/800 MHZ BAND INFORMATION

As described in Section 1.13, 5100 models are starting to ship with a new design RF board. The 800 MHz models with this new board operate on both the 700 and 800 MHz bands. Earlier models can operate in only the 800 MHz band. Other bands remain the same with this new board.

With the 700/800 MHz models, channels can be programmed anywhere in the 700 and 800 MHz bands. For example, Channel 1 can be programmed for 768.000 MHz, Channel 2 for 810.000 MHz, and so on. The only restriction is that the FCC does not permit receiving in one band and transmitting in the other band on the same channel and vice versa.

1.2.3 ANALOG/DIGITAL OPERATION

The 5100-series transceiver uses a digital signal processor (DSP) to provide IF and audio filtering and modulation functions. This allows operation on the various types of channels (see following), backward compatibility with existing equipment, and the ability to operate on various types of radio systems.

Narrow Band Analog - FM modulation is used with a maximum deviation of 2.5 kHz. This mode is usually used in systems with a channel spacing of 12.5 or 15 kHz.

Wideband Analog - FM modulation is used with a maximum deviation of 5 kHz. This mode is usually

used in systems where the channel spacing is 25 kHz or 30 kHz.

Digital - C4FM modulation is used. The voice is digitized, filtered, error corrected, optionally encrypted, and then transmitted. Operation in the Project 25 mode is always digital, and operation in the SMARTNET/SmartZone mode can be either analog or digital. This mode uses a channel spacing of 12.5 kHz.

1.2.4 OPERATING PROTOCOLS

Standard 5100-series transceivers can be programmed for any or all the following operating protocols. The conventional analog protocol is standard and the others are optional and therefore must be enabled by factory programming. Refer to Section 3 for more operation information.

- APCO Project 25 (digital) conventional
- APCO Project 25 (digital) trunked
- SMARTNET®/SmartZone® analog or digital
- Analog conventional

NOTE: Multi-Net operation can be programmed with Ascend models only.

1.2.5 FULL AND LIMITED KEYPAD MODELS

Both DTMF (18-key) and limited (6-key) models are available. The DTMF keypad version includes the 0-9, *, and # keys for making telephone calls (not currently available), entering unit or group ID numbers, and keypad programming.

Both models have the programmable F1-F4 option buttons and an Up/Down switch on the front panel. In addition, both models have a push-button and rotary switch on the top panel and three push-button switches on the side panel that are programmable. A menu mode can also be programmed with both models to select functions that are also selectable by the option buttons. Refer to Section 3 for more information on transceiver operation.

1.2.6 SYSTEMS, CHANNELS, AND ZONES

A zone and channel are selected to place and receive calls. The following describes the relationship between systems, channels, and zones.

Systems

A system is a collection of channels or talk groups belonging to the same repeater site. It defines all the parameters and protocol information required to access a site. Up to 16 systems of any type can be programmed. The maximum number of channels assignable to a system is limited to approximately 512 with the 512 channel option (or the available memory space as described in the following information). The 512-channel option is typically standard with all radios.

Channels

A channel selects an RF channel or talk group as follows:

Conventional Analog Mode - A channel selects a specific radio channel, Call Guard (CTCSS/DCS) squelch coding, and other parameters unique to that channel.

Conventional Project 25 Mode - A channel selects a specific radio channel, NAC squelch coding, talk group ID, and other parameters unique to that channel.

Trunked Project 25 Mode - A channel selects a specific talk group, announcement group, emergency group, and other parameters unique to that talk group.

SMARTNET/SmartZone and Project 25 Trunked Operation - A channel selects a specific talk group, announcement group, emergency group, and other parameters unique to that talk group.

As described in the preceding “Systems” description, a maximum of up to approximately 512 channels can be programmed. Although it is theoretically possible to program any combination of systems that produces up to 512 total channels, the maximum number is also limited by the available memory. For example, since more memory is required to program a SMARTNET system than a conventional system, the total number of channels decreases as the number of SMARTNET systems increases. The programming software displays a bar graph which shows the amount of available memory space that is used by the current data. Refer to Section 4 for more information.

Zones

A zone is a collection of up to 16 channels of any type. For example, a zone could include 12 conventional channels and 4 SMARTNET channels. One use of zones may be to program the channels used for operation in a specific geographical area. Up to 16 zones can be programmed with standard models and up to 32 can be programmed if the 512-channel option is enabled.

1.2.7 PROGRAMMING

Transceiver programming is performed using a PC-compatible computer, the EFJohnson 5100 Programming Cable, and PCConfigure™ programming software (see Table 1-1). A link to the PCConfigure programming manual is located in Section 4.

1.2.8 ALIGNMENT

Transceiver alignment is performed using EFJohnson PCTune software and test cable, and the same computer used for programming (see preceding section). All adjustments are made electronically using the software (no manual adjustments are required). Refer to Section 6 for alignment and performance testing information.

1.3 PRODUCT WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the Warranty Department, EFJohnson Company, 1440 Corporate Drive, Irving, TX 75038-2401. This information may also be requested from the Warranty Department by phone as described in Section 1.7. The Warranty Department may also be contacted for Warranty Service Reports, claim forms, or any other questions concerning warranties or warranty service.

1.4 PART NUMBER BREAKDOWN

The following is a breakdown of the part number used to identify this transceiver. Some combinations are not available.

| |
|-------------------------|
| 242-5MFK-ABC-xxD |
|-------------------------|

M (Model)

- 1 - 5100 series
- 2 - 51SL series
- 5 - Ascend series

F (Frequency Band)

- 1 - VHF (136-174 MHz)
- 2 - UHF (380-450 MHz) Federal Users Only
- 3 - UHF (403-470 MHz)
- 4 - UHF (450-512 MHz)
- 7 - 700-800 MHz
- 8 - 800 MHz
- 9 - 900 MHz

K (Keypad)

- 2 - Standard, Limited keypad (51xx/52xx only)
- 3 - Standard, DTMF keypad (51xx/52xx only)
- 4 - Standard, Limited keypad (55xx only)
- 5 - Standard, DTMF keypad (55xx only)
- 6 - Intrin Safe, Limited keypad (all models)
- 7 - Intrin Safe, DTMF keypad (all models)

A (Antenna)

- 0 - No antenna
- 1 - VHF 136-151 MHz
- 2 - VHF 151-162 MHz
- 3 - VHF 162-174 MHz
- 4 - UHF 403-520 MHz
- 6 - VHF 136-174 MHz
- 8 - 800 MHz

B (Battery)

- 0 - No battery
- 1 - Ultra high capacity, NiMH
- 2 - Clamshell for alkaline batteries
- 6 - Intrin Safe, ultra high cap NiMH

C (Front Housing Color)

- 0 - Black
- 1 - Yellow
- 2 - Orange

xx - Software enabled features/options

These “xx” letters indicate other operating protocols and options that are enabled by factory programming. Options may include encryption, OTAR, 512 Talk Groups, Digital SMARTNET/SmartZone, AES encryption, and others. Use the **Transfer > Read Options From Radio** menu

function of PCConfigure to determine which protocols and options are enabled in your radio (see Section 4).

D Encryption Hardware (see Section 1.13.2)

- 1 - No encryption hardware (software encryp)
- 2 - EFJ SEM module
- 3 - Motorola UCM module

1.5 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a label that is attached to the chassis. The following information is contained in the identification number:

| Model From P.N. | Revision Letter | Manufacture Date | Plant | Warranty Number |
|--------------------|--------------------|---------------------|--------------------|--------------------|
| 51xx | 0 | A | 12 4 | A 12345 |
| | | Week No. of Year | Last Digit of Year | |

1.6 ACCESSORIES

The accessories available for this transceiver are listed in Table 1-1.

1.7 FACTORY CUSTOMER SERVICE

The Customer Service Department of the EFJohnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. Regular Customer Service hours are 8:00 a.m. - 5:00 p.m. Central Time, Monday-Friday. A technical support subscription service is available or support can be purchased on an as-needed basis. The Customer Service Department can be reached using the following telephone numbers:

Toll-Free: (800) 328-3911 (all except Multi-Net)
(800) 295-1773 (Multi-Net only)

FAX: (972) 818-0639

E-Mail: customerservice@efjohnson.com

You can also e-mail a person directly if you know their first initial/last name (example: jsmith@efjohnson.com).

NOTE: Emergency 24-hour technical support is also available at the 800 and preceding numbers during off hours, holidays, and weekends.

When your call is answered at the EFJohnson Company, you will hear a brief message informing you of numbers that can be entered to reach various departments. This number may be entered during or after the message using a tone-type telephone. If you wait until the message is finished and an operator will come on the line to assist you. When you enter some numbers, another number is requested to further categorize the type of information you need.

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

EFJohnson Company
 Customer Service Department
 1440 Corporate Drive
 Irving, TX 75038-2401

1.8 RETURNS FOR REPAIRS

Repair service is normally available through local authorized EFJohnson Land Mobile Radio Service Centers. However, before returning equipment, contact the Customer Service Repair Depot for the correct "Ship To" address. It is suggested that you call Tech Support as they may be able to suggest a solution to the problem that would make return of the equipment unnecessary.

Be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired, whether it is in or out of warranty. These forms are available free of charge by calling Customer Service (see Section 1.7) or by requesting them when you send a unit in for repair. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Include this form in the shipping container with each unit. Your telephone number and contact name are important as there are times when the technicians may have specific questions that need to be answered in order to completely identify and repair a problem.

Table 1-1 Accessories

| Accessory | Part No. |
|-----------------------------------------------------------------------------|---------------|
| Batteries | |
| 3600 mAH NiMH standard | 587-5100-360 |
| 3600 mAH NiMH std intrin safe | 587-5100-361* |
| Battery case for AA alkaline | 250-5100-280 |
| Battery eliminator, 12V cigar. lighter plug | 585-5100-270 |
| Battery Chargers Kits | |
| Charger kit, -210 chgr, -230 PS, US cord | 250-5100-210 |
| Charger kit, -215 chgr, -230 PS, US cord | 250-5100-215 |
| Charger kit, -210 chgr, -230 PS, Eur cord | 250-5100-220 |
| Charger kit, -215 chgr, -230 PS, Eur cord | 250-5100-225 |
| 4-unit charger kit, -240 station, four -210 chargers, US cord | 250-5100-240 |
| 4-unit chgr/cond kit, -240 station, four -215 charger/conditioners, US cord | 250-5100-245 |
| 4-unit charger kit as above, Euro cord | 250-5100-250 |
| 4-unit chgr/cond kit as above, Euro cord | 250-5100-255 |
| Vehicular charger | 585-5100-260 |
| Battery Charger Replacement Parts | |
| Single-unit rapid chgr, w/o power supply | 585-5100-210 |
| Single-unit rapid chgr/cond w/o pwr sup | 585-5100-215 |
| Docking station, 4-unit for -210 (-250 power supply included) | 585-5100-240 |
| Pwr supply, switching 120/230 VAC, 15V 2.0A, -152 cord required | 585-5100-230 |
| Power supply, switching 120/230 VAC 5.0A for docking stat., -152 cord req'd | 585-5100-250 |
| Wall mount kit for 4-unit docking station | 585-5100-245 |
| Power cord, AC 7-1/2 ft US | 597-1001-152 |
| Power cord, AC 6-1/2 ft Euro | 597-1001-153 |
| Antennas | |
| 136-174 MHz helical wideband (red core) | 501-0017-100 |
| 136-151 MHz helical (yellow core) | 501-0017-101 |
| 151-166 MHz helical (black core) | 501-0017-103 |
| 166-174 MHz helical (blue core) | 501-0017-105 |
| 403-520 MHz whip dipole | 501-0017-107 |
| 800 MHz half-wave (red core) | 501-0105-013 |
| 800 MHz 1/4-wave (white core) | 501-0105-012 |
| Carrying Accessories | |
| Leather case with belt flap | 585-5100-120 |
| Leather case with belt flap (for use with alkaline battery clamshell) | 585-5100-121 |
| Leather case w/-132 D-swivel belt loop | 585-5100-122 |

Table 1-1 Accessories (Continued)

| Accessory | Part No. |
|-------------------------------------------------------------------|---------------|
| 2.5" D-swivel belt loop only | 585-5100-130 |
| 3.0" D-swivel belt loop only | 585-5100-132 |
| Radio D-swiv button for -130/-132 loops | 585-5100-127 |
| Nylon case with D-swivel belt loop, blk | 585-5100-125 |
| Nylon case with D-swivel belt loop, yel | 585-5100-126 |
| Belt clip, 2-1/2" std spring loaded | 585-5100-128 |
| Belt clip, 3-1/4" long spring loaded | 585-5100-129 |
| Speaker/Microphones and Earphones | |
| Spkr/mic, coil cord w/2.5mm earphone jk | 589-0015-057* |
| Replacement coil cord for above spkr/mic | 597-2002-101 |
| Earphone kit, coil cord w/2.5mm rt angle plug, for -057 spkr/mic | 589-5100-057* |
| Spkr/mic, public safety, 800 MHz only, 501-0105-012 antenna req'd | 589-0015-058* |
| Earphone kit, coil cord w/2.5mm straight plug, for -057 spkr/mic | 589-5100-059* |
| Earphone adapter, w/3.5 mm thrd jack | 589-5100-051* |
| Lightwght headset w/inline PTT for -051 | 589-0015-059* |
| 1-wire earphone kit, for -051 adapter | 589-5100-053* |
| 2-wire palm mic kit, for -051 adapter | 589-5100-055* |
| Programming Accessories | |
| 5100 Programming Kit (-488 software, -920 cable, CD manual) | 250-5100-003 |
| 5100 Programming Cable | 023-5100-920 |
| 5100 Cloning Cable | 023-5100-930 |
| PCConfigure programming software, CD | 023-9998-488 |
| Adapter, DB9M-DB25F | 515-9000-015 |
| Test Cables and Accessories | |
| PCTune radio tuning software | 023-9998-499 |
| PCTune cable w/2.5mm audio out jack | 023-5100-940 |
| Patch cord, 2.5 mm phone plug to BNC | 023-5100-950 |
| 5100 Tuning Kit (-499 software, -940 cable, -950 patch cord) | 250-5100-005 |
| SMA F to BNC F adapter | 515-3102-050 |
| UI to Logic Board Test Cable | 023-5100-955 |
| Encryption Keyloader Accessories | |
| SMA (PDA) keyloader | 250-5000-945 |
| SMA keyloader to 5100 radio cable | 023-5000-940 |
| SMA keyloader to 5300 radio cable | 023-5000-950 |
| KVL 3000 keyloader to 5100 radio cable | 585-5000-932 |

* Accessory is approved for use with intrinsically safe radios.

When returning equipment for repair, it is also recommended that you use a PO number or some other reference number on your paperwork in case you need to call the repair lab about your unit. These numbers are referenced on the repair order and make it easier and faster to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been given one by the Field Service Department. RA numbers are required for exchange units or if the Field Service Department wants to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request Form sent with the unit. The repair lab will then contact the Field Service Department when the unit arrives. For additional information on factory service, the Depot Service Department can be contacted at the following E-mail address:

depotrepair@efjohnson.com

1.9 REPLACEMENT PARTS

Replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number as described in Section 1.7. When ordering, please supply the part number and quantity of each part ordered. EFJohnson dealers also need to give their account number. If there is uncertainty about the part number, include the designator (C512, for example) and the model number of the equipment the part is from.

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.7.

EFJohnson Company
Service Parts Department
1440 Corporate Drive
Irving, TX 75038-2401

1.10 INTERNET HOME PAGE

The EFJohnson Company has a web site that can be accessed for information on the company about such things as products, systems, and regulations. The address is <http://www.efjohnson.com>.

1.11 INTRINSICALLY SAFE INFORMATION

1.11.1 INTRODUCTION

Intrinsically safe 5100 transceivers have been approved by the Factory Mutual Research Corporation for operation in certain flammable atmospheres. The specific atmospheres in which operation is approved are shown in Section 1.11.5 and also on the label on the back cover of the transceiver.

WARNING

When servicing an intrinsically safe transceiver, these rules must be followed to maintain intrinsic safety:

- Service can be provided only by the factory or by service centers specifically authorized by the Factory Mutual Research Corporation to service EFJohnson intrinsically safe transceivers. Contact Factory Mutual at the following address for information concerning their auditing procedure. Contact the EFJohnson Customer Service Department as described in Section 1.7 if you have questions.

Factory Mutual Research Corporation
1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062
Phone: (617) 762-4300

- Replace the battery pack only with Intrinsically Safe Battery Pack, Part No. 587-5100-361.
- Do not make any modifications to the circuitry.
- When replacing a part, use only the exact replacement part listed in the service manual parts list.
- Do not install any accessory that is not specifically approved for use with intrinsically safe 5100 models. Approved accessories are indicated by an asterisk (*) in Table 1-1.

1.11.2 DEFINITIONS

Intrinsically Safe - This is a fire rating given to these transceivers by the Factory Mutual Research Corporation. When electrical equipment is given this rating, the equipment is considered incapable of releasing suffi-

cient electrical and thermal energy under normal operation or specified fault conditions per the testing standard to cause ignition of a specific flammable or combustible atmosphere in its most easily ignited concentration. In other words, this transceiver should not cause a fire or explosion when used in certain flammable atmospheres.

Fault - A defect or electrical breakdown of any component, spacing, or insulation which alone or in combination with other faults may adversely affect the electrical or thermal characteristics of the intrinsically safe circuit (for example, a shorted transistor).

1.11.3 POSSIBLE IGNITION SOURCES

When a transceiver is evaluated by Factory Mutual, possible sources of ignition are checked. These sources may be electrical (spark) or thermal (heat). The following could be sources of spark ignition:

- Discharge of a capacitive circuit by a fault such as a short circuit.
- Interruption of an inductive circuit.
- Intermittent making or breaking of a resistive circuit.
- Hot-wire fusing.

The following could be sources of thermal ignition:

- Heating of a small-gauge wire or PC board trace.
- High surface temperature of components.

1.11.4 INTRINSICALLY SAFE AND NONINCENDIVE RATINGS

This transceiver is rated intrinsically safe for some types of hazards and nonincendive for other types of hazards. An intrinsically safe rating applies to operation in Division 1 areas, and a nonincendive rating applies to operation in Division 2 areas (see next section). The difference between these ratings is as follows:

The intrinsically safe rating is a higher rating because more severe conditions must be met. To be approved for this rating, the transceiver must not cause ignition of a particular atmosphere if two of the faults

specified in the testing procedure occur. In other words, it must be able to withstand two simultaneous unrelated breakdowns without causing ignition. To receive a nonincendive rating, the transceiver needs to withstand only a single fault without causing ignition of a particular atmosphere.

1.11.5 CLASSIFICATION OF HAZARDOUS AREAS AND ATMOSPHERES

Introduction

This transceiver has been submitted for approval to operate in the following hazardous atmospheres and areas. Contact your sales representative or refer to the label on the back of the transceiver to determine the specific atmospheres and areas for which approval was obtained.

Intrinsically Safe - Class I, II, and III, Division 1, Groups C, D, E, F, and G. *NOTE: Models with the UCM module (P.N. 242-51xx-xxx-xx3) are not approved for Group C operation (see Section 1.12).*

Nonincendive - Class I, Division 2, Groups A, B, C, and D.

Temperature Code - T3C

The meanings of these Class, Division, and Group designations are as follows.

Classification of Hazardous Areas (Division)

Hazardous areas are classified as Division 1 or 2 as shown in Table 1-2. Since a Division 1 area is considered most hazardous, a transceiver approved for a specific Division 1 atmosphere can also be used in the same Division 2 atmosphere. The intrinsically safe rating applies to Division 1 areas and the nonincendive rating applies to Division 2 areas.

Atmosphere Classification (Class/Group)

For the purposes of testing and approval, various atmospheric mixtures have been grouped on the basis of their hazardous characteristics. Equipment is approved for a class of material and also for the specific group of gas, vapor, or dust in that class. Class I materials include gases and vapors, Class II materials

include combustible dusts, and Class III materials include ignitable fibers or flyings. The typical hazardous materials in each group and class are shown in Table 1-3.

Table 1-2 Area Classification

| Division | Area |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Class I and II Materials (Gases, Vapors, and Dusts) | |
| 1 | An area where there is or could be an explosive atmosphere most of the time in normal operation |
| 2 | An area where an explosive atmosphere exists only as a result of a fault (something going wrong) |
| Class III Materials (Fibers or Flyings) | |
| 1 | An area in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used. |
| 2 | An area in which easily ignitable fibers are stored or handled. An exception is in process of manufacture. |

Table 1-3 Material Classification

| Typical Hazard | Group | Class |
|---------------------------------------------------------------------------|-------|-------|
| Acetylene | A | I |
| Hydrogen | B | I |
| Ethylene, ethyl ether, cyclopropane | C | I |
| Gasoline, naphtha, butane, propane, alcohol, acetone, benzol, natural gas | D | I |
| Metal dust including aluminum, magnesium, and their alloys | E | II |
| Carbon black, coal, or coke dust | F | II |
| Flour, starch, or grain dusts | G | II |
| Ignitable fibers/flyings such as rayon or cotton | - | III |

1.12 SECURE COMMUNICATION

NOTE: Refer to Section 11 of the 5100 Operating Manual for more information on secure communication. A link to the operating manual is located in Section 3 of this manual.

General

SecureNet™ and AES voice encryption can be used to provide secure communication with this trans-

ceiver. These protocols digitize the voice and then encrypt it using the DES or AES algorithm and an encryption key. The following types of encryption are available on analog and digital channels:

Analog Conventional and SMARTNET/SmartZone Analog Channels

- DES
- DES-XL (5100 versions with UCM module only; see Table 1-4)

Digital Project 25 and SMARTNET/SmartZone Channels

- DES-OFB (Output Feedback)
- AES (Advanced Encryption Standard). Later 5100 models only. Refer to Section 11 of the 5100 Operating Manual for more information (a link is located in Section 3).

FIPS 140-2 Approved Encryption

DES-OFB and AES encryption is FIPS 140-2 approved in 5100 models equipped with the SEM or UCM encryption module (see Table 1-4). DES encryption with the SEM on analog channels and DES-XL encryption with the UCM is not FIPS approved.

Over-The-Air-Rekeying (OTAR)

Encryption keys are loaded into the radio by OTAR (Over-The-Air-Rekeying) using a KMF (Key Management Facility) and/or a handheld keyloader such as the EFJohnson SMA (Subscriber Management Assistant) or Motorola KVL 3000 Plus with the AES option.

The keyloader is connected directly to the radio using an interconnect cable, and it loads DES, DES-OFB, and AES keys. Currently, OTAR can be used to load DES-OFB keys on Project 25 conventional channels. Future OTAR of AES keys and on Project 25 trunked channels is planned. Refer to Section 8 of the 5100 Operating Manual for more OTAR information. A link to this manual is located in Section 3 of this manual.

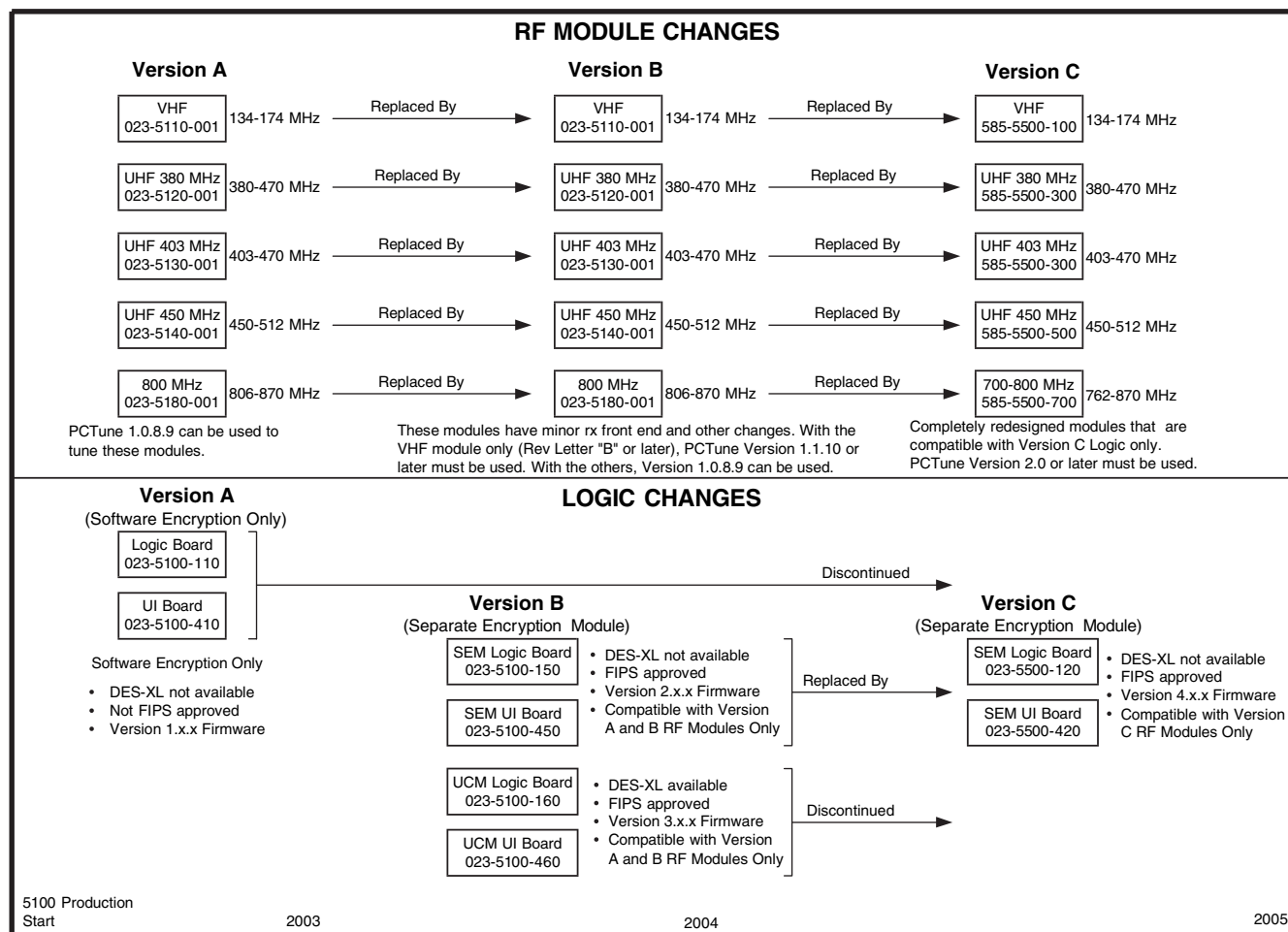


Figure 1-1 Hardware Changes Flowchart

1.13 RADIO HARDWARE CHANGES

NOTE: Version A/B/C references in the following information are for descriptive purposes in this manual only and do not correspond to any radio revision letters or letters on the boards.

1.13.1 RF MODULE CHANGES

As shown in Figure 1-1, there have been three significant changes to the RF module used in 5100 series radios:

Version A - This is the original module version that was used until approximately late 2003. All versions of PCTune can be used to tune radios with these modules. The schematic diagrams and board layout for this VHF board are located in the Unrev_Bd folder and the other boards are located in Section 8.

Version B - The changeover to this version occurred starting in late 2003. This change was made because of part obsolescence. Significant changes occurred to only the VHF board, so this is the only board with revised schematics and layouts in this manual. With the UHF and 800 MHz boards, only minor layout and value changes occurred. The Version B boards are being replaced by the following Version C boards as they become available.

NOTE: PCTune, Version 1.10.0 or later must be used to tune VHF radios with this board (see following).

PCTune Version 1.10.0 or later must be used to adjust radios with the Version B VHF board because of changes made in the front end. The earlier version (1.0.8.9) can still be used to tune all other Version B and all Version A boards.

The Revision Letter in the radio identification number (see Section 1.5) can be used to determine if a VHF radio has this new Version B board. Radios with a Revision Letter of “B” or later have the new board and PCTune 1.10.0 or later must be used.

Version C - These boards are a completely new design. Highlights of this board version are as follows:

- Because of different interface requirements, the new Version C logic and UI boards described in the next section must be used. This logic is PowerPC-based, similar to Version A and B.
- A new version of the PCTune software (2.0 or later) is required to tune radios with these boards.
- The new 800 MHz version of this board operates on both 700 and 800 MHz channels instead of only 800 MHz channels like the A and B versions. Therefore, radios with the Version C board can operate on channels from 762-870 MHz, while radios with the earlier Version A and B boards can operate only on channels from 806-870 MHz.

Radios with this new 700/800 MHz RF board have a “7” as the “F” character of the radio part number (see Section 1.4), while radios with the older A and B versions have an “8” for this character.

1.13.2 LOGIC AND UI BOARD CHANGES

As shown in Figure 1-1 and Table 1-4, there have been three significant changes to the control logic used in 51xx series radios. More information on these changes follows.

NOTE: The firmware version number (1.x/2.x/3.x) is briefly displayed when radio power is turned on.

Version A - This version of logic and UI boards provides software generated encryption (Version 1 in Table 1-4). DES-XL and FIPS 140-2 approval is not available with these models.

Version B - This version began shipping in mid 2003 to provide FIPS 140-2 approved and DES-XL encryption. SEM and UCM versions of these boards are available (Versions 2 and 3 in Table 1-4). These boards have separate encryption modules to provide encryption instead of doing it through software. The SEM and UCM versions are functionally the same except only the UCM version provides DES-XL encryption. Normally, the SEM version is used unless DES-XL encryption is required.

Version C - This version of the logic and UI boards is a new design that is required to interface with the new Version C RF module. Only a SEM version will be offered (similar to Version 2 in Table 1-4). This version of boards has more Flash and RAM memory to allow additional features to be added if necessary. This logic version uses Version 4.x.x firmware.

Table 1-4 51xx Family Logic and Firmware Versions

| Logic/Radio Version [1] | Application (Firmware) Code Base | Analog Channel Encryption | | Digital Channel Encryption | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------|--------|-------------------------------|-----|
| | | DES | DES-XL | DES-OFB | AES |
| Version 1 (No Module/Software Encryption) Current standard version which uses the -110 Logic board and -410 UI Board. Not FIPS approved. | 1.xx | Yes | No | Yes | Yes |
| Version 2 (uses EFJ SEM module) Current version which has the EFJohnson SEM (Subscriber Encryption Module) on the logic board. This version uses the -150 Logic and -450 UI boards. All radios include the SEM, and the desired encryption options (if any) are enabled by factory programming. FIPS approved. | 2.xx | Yes | No | Yes | Yes |
| Version 3 (uses Motorola UCM module) Current version which has the Motorola UCM (Universal Crypto Module) on the logic board. This version uses the -160 Logic and -460 UI boards, and is ordered when DES-XL encryption is required. FIPS approved. | 3.xx | Yes | Yes | Yes | Yes |
| Version 4 (uses EFJ SEM module) New version designed for use with the new Version C RF modules described in Section 1.13.1. It uses the same EFJohnson SEM (Subscriber Encryption Module) as Version 2 boards above. This version uses 5500-120 Logic and 5500-420 UI boards. All radios include the SEM, and the desired encryption options (if any) are enabled by factory programming. FIPS approved. | 4.xx | Yes | No | Yes | Yes |
| [1] The version number of Versions 1-3 is also indicated by the 13th digit of the radio part number (242-51xx-xxx-xxV). | | | | | |

5100 PORTABLE SPECIFICATIONS

The following are general specifications intended for use in testing and servicing this transceiver. For current advertised specifications, refer to the specification sheet available from your sales representative. Values are typical and are subject to change without notice.

GENERAL

| | |
|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency Range | VHF: 136-174 MHz UHF: 380-470 MHz, 403-470 MHz, 450-512 MHz 700/800 MHz: 762-870 MHz, 800 MHz: 806-870 MHz (see Section 1.2.2) |
| Available Operating Modes | Conventional analog, Project 25 conv. and trunked, SMARTNET/SmartZone analog and digital (see Section 1.2.4) |
| Channels/Talk Groups | Up to 512 (dependent on available memory) |
| Transmit/Receive Separation | Any frequency within the range |
| Channel Spacing | VHF: 12.5, 25, and 30 kHz UHF: 12.5 and 25 kHz 700/800 MHz: 12.5 and 25 kHz |
| Maximum Deviation | 25 kHz analog - 5 kHz 12.5 kHz analog - 2.5 kHz 12.5 kHz analog NPSPAC - 4.0 kHz |
| Frequency Stability | VHF/UHF - 2.0 PPM, 700/800 MHz - 1.5 PPM (–22 to +140° F or –30 to +60° C) |
| Dimensions (w/o antenna) | 6.7" H x 2.52" W x 1.9" D (17.0 cm x 6.4 cm x 4.8 cm) |
| Weight (w/std battery) | 24 oz. (675 g) |
| Supply Voltage | 7.2 volts DC nominal |
| Battery Life | 13 hours typical w/std 3600 mAH battery |
| Current Drain (maximum w/o backlight, w/backlight add 100 mA) | Standby - 200/210 mA (with Ver A B/Ver C RF board, see Section 1.13.1) Receive (rated audio out) - 400/430 mA Low Tx Power - 1.5/1.3 A High Tx Power - 2.8/2.4 A |

RECEIVER

| | |
|------------------------------|----------------------------------------------------------------------------|
| Sensitivity | 0.25 μ V (analog mode 12 dB SINAD), 0.25 μ V (digital mode 5% BER) |
| Selectivity | –75 dB |
| Spurious and Image Rejection | –75 dB (VHF/UHF), –80 dB (700/800 MHz) |
| Intermodulation | –78 dB (VHF), –77 dB (UHF), –75 dB (700/800 MHz) |
| Maximum Frequency Spread | Any spread within the range |
| Audio Power Output | 500 mW |
| Audio Distortion | Less than 2% at 1 kHz |

TRANSMITTER

| | |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| RF Power Output | VHF: 5W (high), 1W (low) UHF: 4W (high), 1W (low) 700 MHz: 2.5W (high/TA), 1W (low) 800 MHz: 3W (high), 1W (low), 2.5 TA |
| Spurious and Harmonic Emissions | –70 dB (VHF/UHF), –75 dB (700/800 MHz) |
| FM Hum and Noise | –45 dB at 25 kHz bandwidth |
| Audio Modulation | 16K0F3E, 8K10F1E (all), 11K0F3E (VHF/UHF), 14K0F3E (700/800 MHz) |
| Audio Distortion | Less than 2% at 1 kHz |
| Maximum Frequency Spread | Any spread within the band |

SECTION 2 BATTERY, ACCESSORY, AND DISASSEMBLY INFORMATION

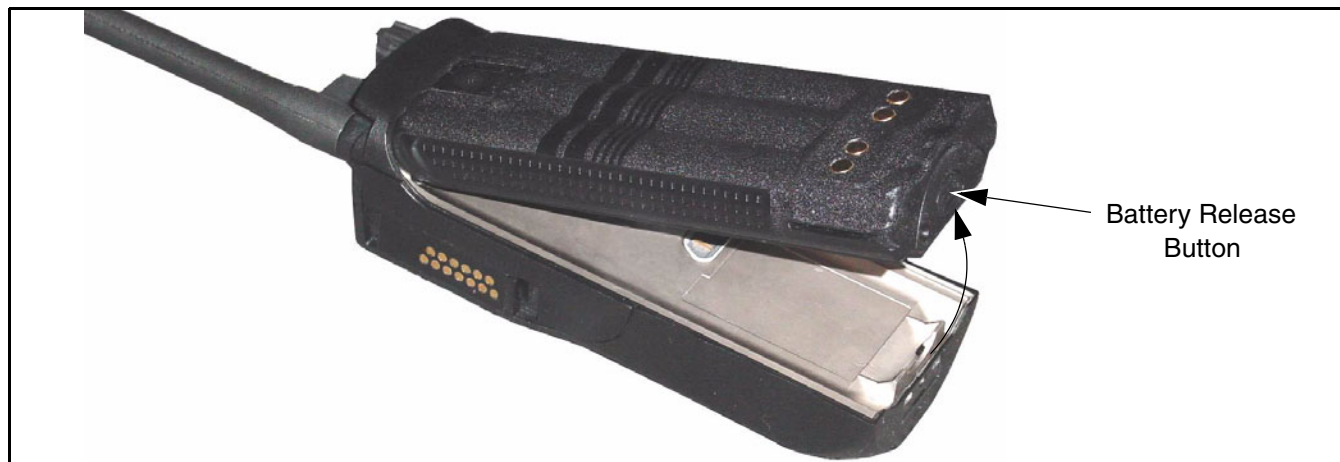


Figure 2-1 Battery Removal

2.1 BATTERY INFORMATION

2.1.1 BATTERY REMOVAL/INSTALLATION

To remove the battery from the radio for recharging or replacement, press the release button (see Figure 2-1) and then rotate it upward to the approximate point shown and remove it from the radio.

2.1.2 BATTERY CHARGING

NOTE: Do not charge the battery with radio power on (see following).

The battery can be charged separately or while attached to the radio. When it is charged while attached to the radio, radio power should be turned off. If it is not, the battery begins slowly discharging when the trickle charge mode is entered. The trickle mode is indicated by a green Ready indication, and it is entered automatically when the battery is nearly fully charged. Gradual discharging occurs in the trickle mode because the charge current of approximately 50 mA is less than the radio standby current of 200 mA.

CAUTION: Do not transmit in close proximity to the charger base (see following).

Do not expose the charger base to high level RF signals while a battery is being charged because this may cause a charger fuse to blow (especially in the UHF range). Radios programmed for SMARTNET/SmartZone operation, for example, may affiliate while in the charger which causes them to key automatically. Therefore, do not leave radio power on while charging as described above.

2.1.3 PREVENTING LOSS OF ENCRYPTION KEYS

NOTE: Later models (manufactured in 2003 and later) have reduced storage time as follows.

If Infinite Key Retention is not programmed, the transceiver must be connected to a constant power source to preserve the encryption keys in memory. Storage capacitors maintain the supply voltage (and these keys) for approximately 30 seconds to allow the battery to be changed. Therefore, when changing the battery of a transceiver containing keys, make sure to reattach another battery within 30 seconds.

Models with Flash code 1.11.0 or later can be programmed for Infinite Key Retention. The keys are then stored in memory and are not lost, even if power is disconnected for an extended period.

2.1.4 BATTERY CARE

WARNING: Do not incinerate a battery pack because it may explode. Also, do not short circuit the terminals because the battery pack and the object causing the short may become very hot. Do not disassemble or modify a battery pack.

Proper battery care enhances the useful life of the battery. The battery should be recharged as soon as practical after the low battery indication appears (see Section 3). Follow the charging instructions in the manual included with the charger. When the battery

fails to hold a charge or provides only a very short operating time, it must be replaced with a new unit.

A fully charged battery provides approximately 13 hours of service before recharging is required. This time assumes that 5% of the time is spent transmitting, 5% in the receive unsquelched mode, and 90% in the receive squelched mode. The operating time may be less if more time is spent in the transmit or unsquelched modes, or if the battery is not fully charged or its capacity has deteriorated. Be sure to dispose of the nickel metal-hydride (NiMH) battery pack in accordance with local waste regulations.

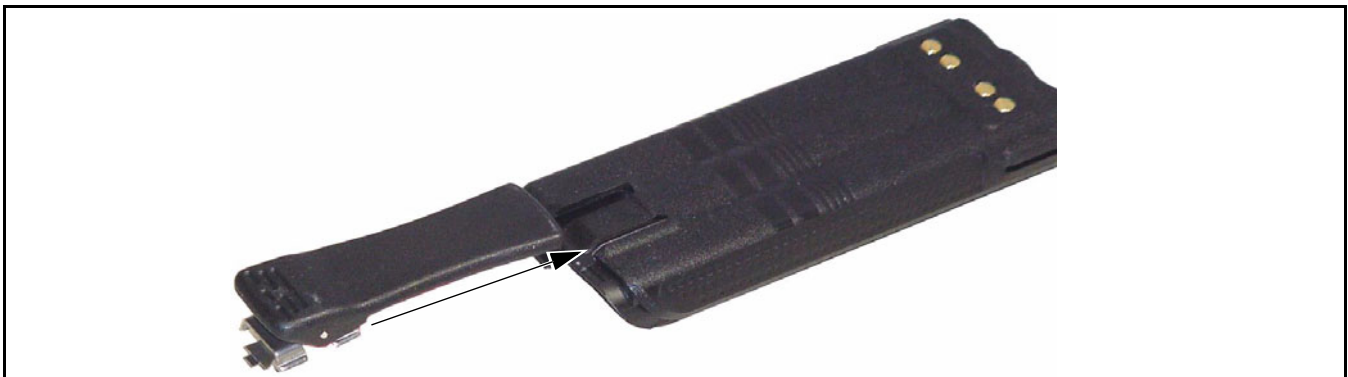


Figure 2-2 Belt Clip Installation

2.2 BELT CLIP INSTALLATION

Remove the battery and slide the belt clip into the slot on the battery as shown in Figure 2-2. To remove the clip, simply slide it out. It is held in place by the chassis when the battery is installed on the radio.



Figure 2-3 Accessory Installation

2.3 ACCESSORY INSTALLATION

To connect an accessory such as a speaker-microphone to the transceiver, refer to Figure 2-3 and proceed as follows:

1. Remove the dust cover over the accessory jack on the side of the transceiver.
2. Insert the hook of the accessory connector into the slot on the side of the transceiver.
3. Hold the latch open, press the connector against the transceiver, and then release the latch to lock the connector in place.
4. Install the included locking screw in the latch tab in the location shown.

Option Select Lines

Opt Sel 1 (pin 1) and Opt Sel 2 (pin 5) of the UDC (accessory) connector indicate to the control logic when an accessory is connected and what accessory is installed. These lines function as follows:

Opt Sel 1 and 2 High (3.3V) - This is the normal operating condition in which no accessory is connected. Both lines are pulled high (3.3V) by internal pull-up resistors.

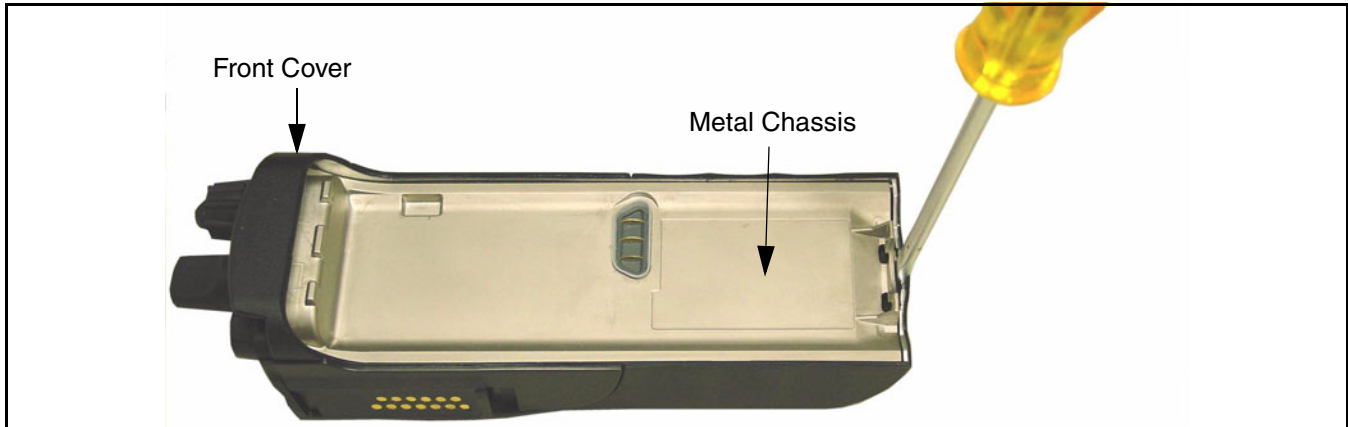
Opt Sel 1 Low - A speaker-microphone or some other accessory is connected. Opt Sel 2 then functions as an external PTT line (low = PTT), and the radio PTT switch is also functional. The internal speaker and microphone are disabled.

Opt Sel 1 High, Opt Sel 2 Low - The encryption keyloader is connected.

2.4 TRANSCEIVER DISASSEMBLY

2.4.1 SEPARATING FRONT COVER AND CHASSIS

1. Remove the antenna.
2. Insert a small flat-blade screwdriver or similar tool between the plastic front cover and metal chassis as shown below. Carefully lift the chassis out of the cover with the screwdriver blade. Raise it to approximately the point shown in the next illustration.



3. Slide the chassis out of the top part of the front cover.



NOTE: Before reassembling the front cover and chassis, make sure the UDC (accessory) connector flex circuit is flat against the side of the front cover. If it is not, the RF board shield clip may catch and damage it.

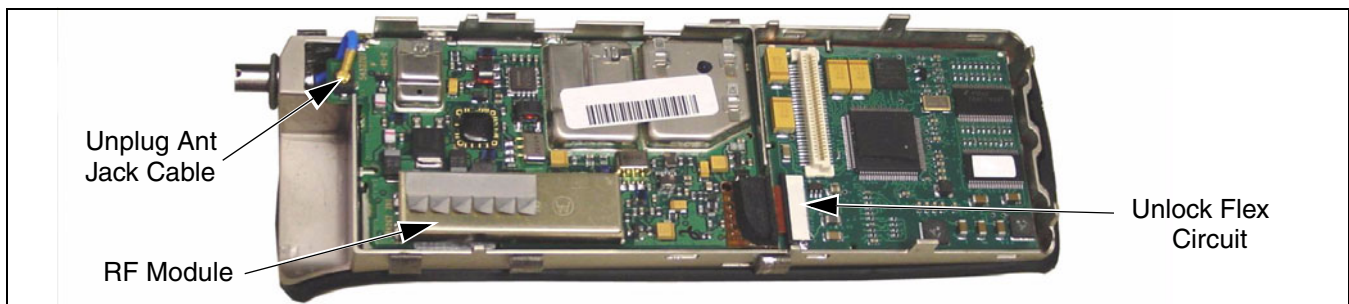
4. When reassembling, make sure the perimeter gasket is in place, and then use the screwdriver blade again as a guide to prevent damage to the bottom part of the gasket as the chassis slides back in place. Firmly press the chassis and the cover together until they snap in place.

2.4.2 REMOVING RF AND LOGIC BOARDS FROM CHASSIS

1. Separate the front cover and chassis as described in the preceding section. The RF and logic boards are located inside the metal chassis as shown below.



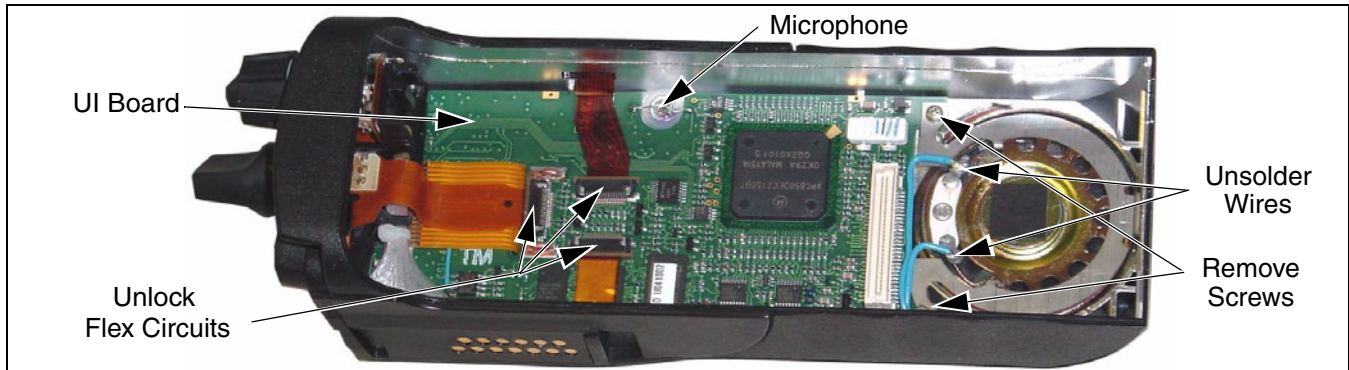
2. Remove the shields over the RF and logic boards. These shields insert in slots on one side of the chassis and then clip to the other side of the chassis. These shields also hold the boards in place.
3. Unplug the antenna cable from the RF board using a plier or similar tool at the location shown below. Unlock the logic board flex circuit by sliding the tab on the connector outward. The RF and logic boards can now be removed.



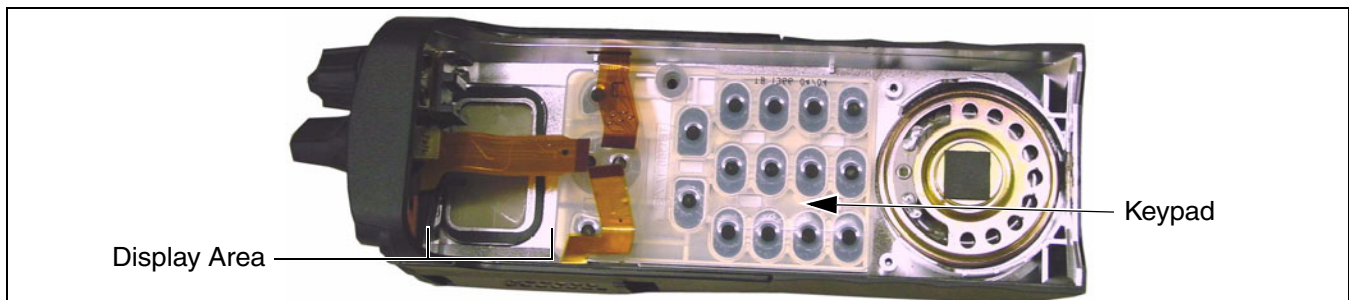
4. When handling these boards, minimize bending of the flex circuit to prevent it from being damaged. Before replacing the RF board, make sure there is adequate heat sink compound on the pad under the RF module.

2.4.3 REMOVING UI (USER INTERFACE) BOARD

1. Separate the front cover and chassis as described in Section 2.4.1. The UI board is located inside the front cover as shown below.



2. Unlock the three flex circuits shown above by sliding the tab on each connector outward. Carefully slide the flex circuits out of the connectors, taking care to minimize bending which could crack the traces.
3. Remove the two screws shown above. If required, also unsolder the two speaker wires.
4. Carefully lift the bottom end of the UI board upward (guide the microphone out of its cavity). Then slide the UI board out of the radio.
5. When reinstalling the UI board, the display assembly on the bottom of the board must slide into the area above the keypad (see following illustration). If the UI board does not lie flat against the keypad after it is installed, the display is probably hanging up on the keypad. Do not force it in place. Reorient the keypad and UI board as required until the display slides into place. Also make sure that the optic fiber bundle slides under the boss on the switch assembly, and the microphone is properly positioned back in its cavity.



2.4.4 REMOVING SWITCH ASSEMBLY

1. Separate the front cover and chassis as described in Section 2.4.1. Then remove the UI board as described in the preceding section.
2. Pull the rubber knobs and plastic channel number ring off the shafts.
3. To remove the position indicator ring under the channel knob, turn the channel switch so that the flat part of the shaft is toward one of the tangs (see below). Then insert a tweezers or similar tool under both tangs and push it inward to release the tangs from the groove in the shaft.



4. Remove the spanner nut on each shaft and slide the switch assembly out of the cover.

SECTION 3 OPERATION

3.1 GENERAL

The operation of the 5100 transceiver is included in a separate manual that is included on the CD-ROM with this manual.

SECTION 4 TRANSCEIVER PROGRAMMING

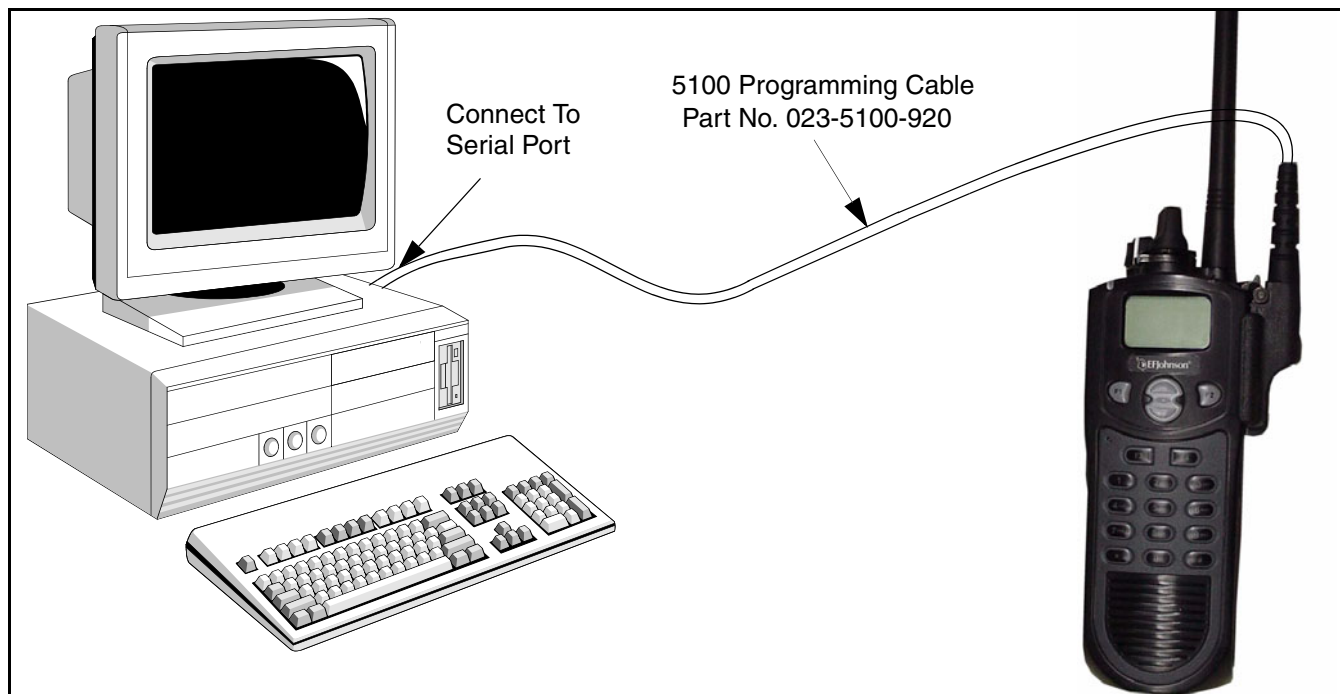


Figure 4-1 Programming Setup

4.1 PROGRAMMING SETUP

The following items are required to program the transceiver. The part numbers of this equipment are shown in Table 1-1 in Section 1. The programming set-up is shown above.

- Computer running Windows® software
- 5100 Programming Cable, Part No. 023-5100-920
- PCConfigure programming software, Part No. 023-9998-488.

NOTE: The -920 cable, -488 software, and a CD manual are included in the 5100 Series Programming Kit, Part No. 250-5100-003.

4.2 COMPUTER DESCRIPTION

The computer used to run this program should meet the following minimum requirements:

The computer used to run this program should meet the following minimum requirements:

- Windows 95/98/NT/2000
- Pentium® processor or equivalent
- At least 16 MB of RAM
- A hard disk drive with at least 4 MB of free space
- A CD-ROM drive
- An available serial port

4.3 USING THE PCCONFIGURE SOFTWARE

The PCConfigure software is described in a separate manual included on the CD-ROM with the service manual.

Tone (CTCSS) and digital (DCS) Call Guard tones and 800 MHz channel frequencies are located in the back of the above manual.

NOTE: The latest programming manual is also included on the PCConfigure CD-ROM.

4.4 CLONING PROCEDURE

The Clone feature allows one radio to be used to program another with identical information. The PCConfigure programming software is not required. Only conventional analog and Project 25 zones can be programmed with this feature. SMARTNET/Smart-Zone and Project 25 trunked information is not transferred. The Clone option switch must be programmed on the master radio. With the latest 5100 versions, both wireless and wired cloning are available.

For more information on cloning one radio with another, refer to Section 14 of the PCConfigure Manual included on the CD-ROM with this service manual. To open this manual, click the link on the preceding page or go to the PCConfigure directory on the CD and open the file “Manual.pdf”.

SECTION 5 CIRCUIT DESCRIPTION

5.1 GENERAL OVERVIEW

5.1.1 INTRODUCTION

The EFJohnson 5100 series digital portable radio uses a PowerPC®-based controller and a Digital Signal Processor (DSP) to provide the following modes of operation:

Narrowband Analog - FM modulation with a maximum deviation of 2.5 kHz. This mode is usually used in systems where the channel spacing is 12.5 kHz. Call Guard (CTCSS or DCS) subaudible squelch signaling can be used in this mode.

Wideband Analog - FM modulation with a maximum deviation of 5 kHz. This mode is usually used in systems where the channel spacing is 25 kHz or 30 kHz. Call Guard (CTCSS or DCS) subaudible squelch signaling can be used in this mode.

Project 25 Digital - The voice is digitized, error corrected, optionally encrypted and transmitted using C4FM modulation according to the Project 25 standard. This mode can be used in channel spacings of 12.5 kHz.

The DSP processes the received signals and generates the appropriate output signals. The microcontroller controls the hardware and provides an interface between hardware and DSP.

PC Boards

This radio contains the following PC boards:

- RF Board
- Logic Board
- User Interface (UI) Board
- Five flex circuits that provide interconnection with the RF board, display, top panel controls, side buttons, and UDC (accessory) connector.

The User Interface Board provides the input/output interface for the user. It contains the PowerPC processor which is the main controller for the transceiver. It also contains the keypad and has inputs for

the various buttons and switches. It also controls the display and performs all RS-232 communications between the radio and remote computer stations for the purposes of radio programming, tuning, encryption key loading and software downloading.

The Logic Board contains the digital audio processing circuitry which includes the CODEC (or ADSIC with early versions) and DSP devices.

NOTE: The next two sections (5.1.2 and 5.1.3) describe operation with the revised logic (Version C in Section 1.13). Generally, the Digital IF chip on the revised RF board replaces the ABACUS chip on the early version, and the CODEC on the revised logic board replaces the ADSIC chip on the early version.

5.1.2 ANALOG MODE

Receive Mode

The signal is routed from the antenna connector to the RF Board where it is filtered, amplified, and mixed with the first local oscillator frequency generated by the synthesizer. The resulting IF signal is also filtered and amplified and sent to the AD9864 digital IF chip.

The signal is then mixed with the second local oscillator frequency to create a second IF signal. The second IF signal is then sampled and downconverted to baseband. The baseband signal is then decimated to a lower sample rate that is selectable at 20 kHz. This signal is then routed via a serial interface from the IF chip to the DSP on the logic board.

On the logic board the DSP digitally filters the input signal and performs frequency discrimination to obtain the message signal. The DSP first performs a carrier- detection squelch function on the radio. If a signal is determined to be present, the audio portion of the signal is resampled and then filtered appropriately. The filtered signal is then routed back to a D/A in the CODEC to produce an analog signal for output to the audio power amplifier and then the speaker. Any detected signaling information is decoded and the resulting information is sent to the microcontroller.

VHF RF BOARD (VERSION C)

Transmit Mode

The signal from the microphone is amplified and then routed to the CODEC chip where it is first digitized and then sent to the DSP. The DSP performs the required filtering, adds the desired signaling, converts the sample rate and then sends the resulting signal back to a D/A in the CODEC to produce the analog modulation signals for the VCOs. The modulated VCO signal is then sent to the RF power amplifier and transmitted.

5.1.3 PROJECT 25 DIGITAL MODE

Introduction

In Project 25 Digital Mode, the carrier is modulated with four discrete deviation levels. These levels are ± 600 Hz and ± 1800 Hz. Digitized voice is created using an IMBE™ vocoder.

Receive Mode

The signal is processed in the same way as an analog mode transmission until after the squelch function is performed. If a signal is detected to be present, the DSP resamples the signal from 20 kHz to 24 kHz. This is done so that the sample rate is an integer multiple (5x) of the data rate of the digital modulation which is 4800 symbols/sec (9600 bits/sec).

The resampled signal is then processed by a demodulator routine to extract the digital information. The resulting bit stream (9600 bps) is sent to a routine that performs unframing, error-correction, and voice decoding. The result of these operations is a reconstructed voice signal sampled at 8 kHz. The sampled voice signal is sent to a D/A in the CODEC to produce an analog signal for output to the audio power amplifier and speaker.

Transmit Mode

The microphone signal is processed as in the analog mode until it reaches the DSP. At this point the audio signal is processed by a voice encoding routine to digitize the information. The resulting samples are then converted to a bit stream that is placed into the proper framing structure and error protected. The resulting bit stream has a bit rate of 9600 Hz.

This bit stream is then encoded, two bits at a time, into a digital level corresponding to one of the four allowable frequency deviations. This produces 16-bit symbols with a rate of 4800 Hz. The symbols are resampled to a rate of 48 kHz and filtered to comply with channel bandwidth requirements. The filtered signal is then sent to a D/A in the CODEC to produce the analog modulation signal for the VCO. The modulated VCO signal is then mixed up to the final transmit frequency and then sent to the RF PA for transmission.

5.2 VHF RF BOARD (Version C)

NOTE: The following describes the new revised Version C RF board described in Section 1.13.1. The RF Board is not field serviceable. It must be replaced as a unit with a new board.

5.2.1 RECEIVER

Front End Bandpass Filter

A harmonic filter is followed by a PIN diode transmit/receive switch. Following this switch a fixed tuned bandpass filter is used at the front-end of the receiver. This filter provides first image rejection with minimal loss in order to provide the desired receiver sensitivity. Following the filter a variable attenuator is used to increase the dynamic range of the receiver when receiving high level signals.

Front End LNA and Bypass Switching

The Low Noise Amplifier (LNA) is critical in determining the overall noise figure of the receiver chain. An MGA-71543 amplifier (U39) provides optimum noise figure, gain, intercept point, and power consumption.

Post-LNA Bandpass Filters

An additional bandpass filter is located after the LNA. This filter is identical to the front end filter previously described and provides additional image rejection.

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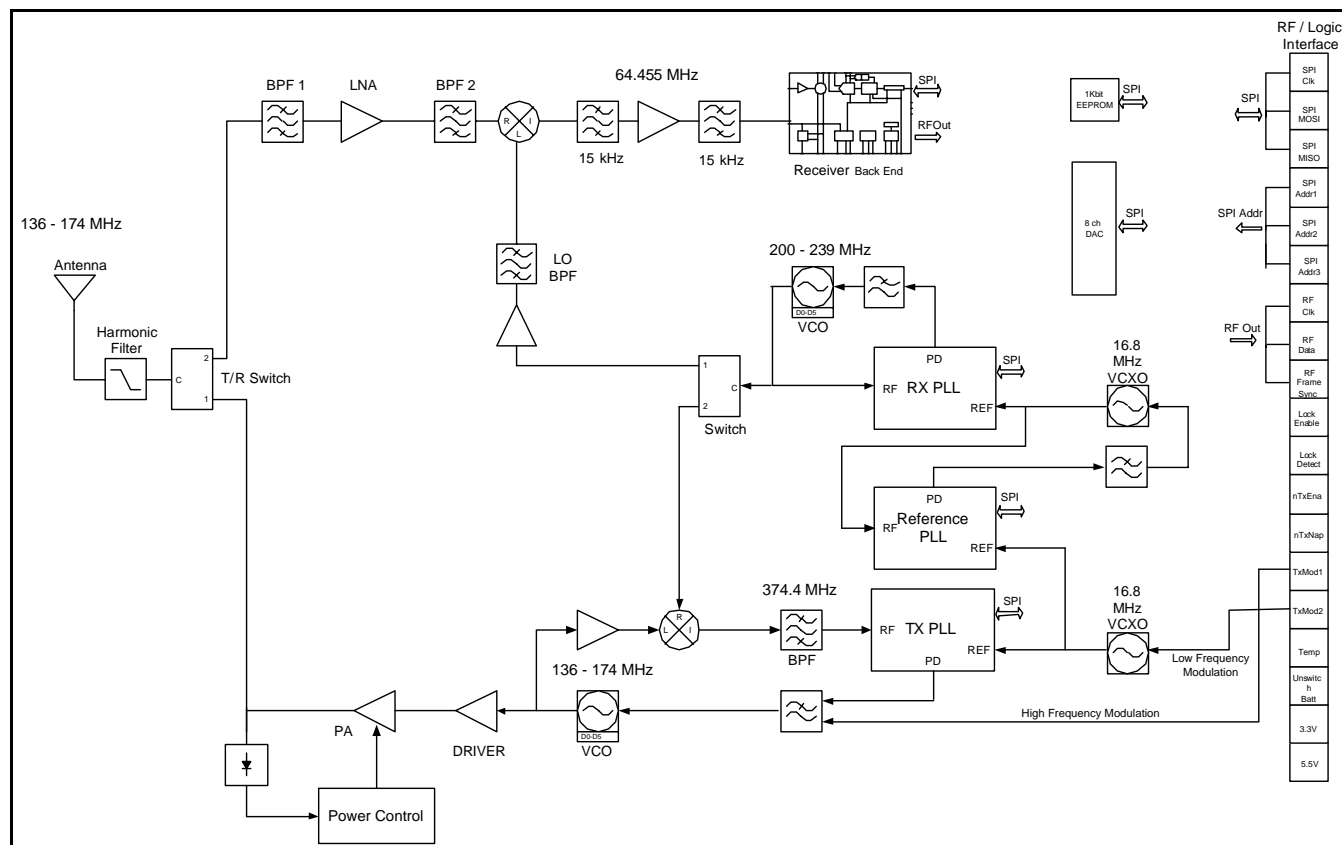


Figure 5-1 VHF RF Board Block Diagram (Version C)

Mixer and LO Filter

A double-balanced, low-level ADEX-10L mixer (MX1) with a LO drive level of +4 dBm is used for the first conversion. This mixer provides a good dynamic range with a 3 dB lower LO drive than the more traditional +7 dBm drive mixers. This reduces power consumption and also the conducted and radiated local oscillator leakage from the receiver.

High side injection is used to provide optimum spurious performance. A LO filter prior to the mixer LO port reduces wideband noise from the LO synthesizer which improves receiver sensitivity.

IF Filter and Amplifier

A two-pole 64.455 MHz crystal filter (U2) is used to provide the desired level of adjacent channel rejection while providing minimal amplitude and phase distortion within a 25 KHz bandwidth. Shields are installed around the crystal filter to provide sufficient isolation to meet the second image response specifica-

tions and to minimize noise pickup by the impedance-matching inductors (L1, L2, L3, L4 and L7.)

A transistor IF amplifier (Q1) and supporting circuitry is required to boost the signal strength, thereby reducing the overall noise figure. The noise figure, signal gain, intercept point, and power consumption are optimized in this design. An additional two-pole 64.455 MHz crystal filter (U25) is used to increase the adjacent channel rejection. An LC circuit provides the required impedance matching between the output of the IF filter and the input of the backend chip (U11.)

Back End IC

An Analog Devices AD9864 IF Digitizing Subsystem IC (U11) provides a variety of functions for the receiver as follows:

Second Local Oscillator - A varactor-tuned transistor (Q2) oscillator is phase-locked to a fixed frequency of 62.355 MHz for converting the first

VHF RF BOARD (VERSION C)

IF of 64.455 MHz to a second IF frequency of 2.1 MHz. Phase Locked Loop circuitry inside of the AD9864 operates with a phase-detector frequency of 15 kHz.

Second Conversion Mixer and Filtering - A mixer inside the AD9864 converts from the first IF of 64.455 MHz to the second IF of 2.1 MHz. External filters (L29 and L30) provide IF bandpass filtering. Additional filtering is provided by the inherent operation of the sigma-delta analog/digital converters.

Gain Control - This device provides up to 12 dB of AGC range via a combination of analog and digital controls. Additionally, there is a 16 dB attenuator in the front end. The optimum settings are controlled by the host microprocessor.

Analog/Digital Conversion and Processing - Sigma-delta converters provide I and Q sampling directly from the second IF frequency. The resulting digital words are first filtered by internal programmable FIR filters and then clocked out of the AD9864 via a serial data bus using a programmable data rate.

5.2.2 SYNTHESIZER

The following three phase locked loops are used in the VHF radio module to provide the required overall functionality and performance levels.

Receive PLL

The receive PLL provides a signal that is in the frequency range of 200 to 239 MHz. In receive mode it is programmed for a frequency that is 64.455 MHz above the receive frequency. In transmit mode it is programmed for a frequency that is equal to 374.4 MHz minus the desired transmit frequency.

Transmit PLL

The transmit PLL phase locks a transmit oscillator that is operating at an output frequency of 138 to 174 MHz. The RF signal into the PLL chip is created by mixing the transmit frequency with the receive PLL frequency to generate a mix frequency of 374.4 MHz. This provides low frequency modulation of the VCO by modulating the transmit PLL reference frequency.

Reference PLL

The reference PLL phase locks the receive PLL reference oscillator to the transmit PLL reference oscillator with a loop bandwidth of less than 10 Hz. This PLL ensures that the center frequency of both reference oscillators are the same. It also limits the modulation of the receive PLL reference oscillator by the low frequency modulation applied to the transmit PLL reference oscillator.

PLL IC

Two CX72301 sigma-delta modulated PLL chips (U29 & U46) are used for the PLLs described above. This PLL chip provides good phase noise capabilities to reduce adjacent channel interference and quick switching between the receive and transmit modes.

Reference Oscillators

One 16.8 MHz oscillator (Y1) is used as the frequency reference for the receive PLL and also for the receiver backend IC.

The other 16.8 MHz oscillator (Y2) is used as the frequency reference to the transmit PLL. The center frequency of this oscillator is corrected using a DC tuning voltage from the digital board in the receive mode and it is modulated with voice or data in the transmit mode.

The receive PLL reference oscillator is phase locked to the transmit PLL reference oscillator as discussed above.

Analog Switches and PLL Loop Filters

An analog switch (U17) provides faster switching of signals during channel changes by varying the time constant of the PLL loop filter.

5.2.3 TRANSMITTER

Modulation

A “dual-port” modulation scheme is used to provide the DC coupling of the signal required for data modulation applications. In this scheme, modulation applied to the transmit PLL frequency reference provides low-frequency modulation, and modulation

VHF RF BOARD (VERSION C)

applied to the transmit PLL transmit VCO (U47) provides high-frequency modulation. Signals for both modulation ports are provided by DACs on the digital board.

Power Amplifier

The power amplifier (U3) is a Mitsubishi RA07M1317M module. This PA module provides the desired RF power output level and is stable over a wide range of VSWR conditions. The PA is driven by a SGA-6589 driver (U20) that typically provides +21 dBm output power. The PA is turned on and off by switching the power to this driver via transistor D10.

ALC

To maintain the specified transmitter output power level, Automatic Level Control (ALC) is used to control the drive level to the PA. The detected forward power is compared to a reference level provided by the digital board via op amp U21A. The resulting error voltage is applied to a power level control port of the power amplifier module. Transmitter on/off splatter filtering is provided by an RC network (R76, R12, C43 and C141.)

T/R Switching and Harmonic Filter

The output of the power amplifier is applied to the transmit/receive RF PIN switch (D12/D13). This is a high dynamic-range switch that is capable of passing the desired transmit power with minimal compression. Any harmonics generated by the PA module and the RF T/R switch are filtered by a harmonic filter that is located between the RF T/R switch and the antenna jack.

5.3 UHF RF BOARD (VERSION C)

NOTE: The following describes the new revised Version C RF board described in Section 1.13.1. The RF Board is not field serviceable. It must be replaced as a unit with a new board.

5.3.1 RECEIVER

Front End Bandpass Filter

A harmonic filter is followed by a PIN diode transmit/receive switch. Following the switch, two

UHF RF BOARD (VERSION C)

fixed tuned bandpass filters are used in the front-end of the receiver. Depending on the desired receive band, the appropriate filter is selected using RF switches (U37/U41). This filter provides first-image rejection with minimal loss in order to provide the desired level of receiver sensitivity. A variable attenuator, which follows the filter, increases the dynamic range of the receiver when receiving high-level signals.

Front End LNA and Bypass Switching

The Low Noise Amplifier (LNA) is critical in determining the overall noise figure of the receiver chain. An MGA-71543 amplifier (U39) provides optimum noise figure, gain, intercept point, and power consumption.

Post-LNA Bandpass Filters

Additional bandpass filters are positioned after the LNA. These filters are identical to the front-end filters previously described. RF switches U42 and U40 are used to select between the two bands. These filters provide additional image rejection.

Mixer and LO Filter

A double-balanced, low-level ADEX-10L mixer (MX1) with a LO drive level of +4 dBm is used for the first conversion. This mixer provides good dynamic range with a 3 dB lower LO drive than the more traditional +7 dBm drive mixers. This reduces power consumption and also the conducted and radiated local oscillator leakage from the receiver.

For the low band UHF version, a high-side mix is used for the 380-444 MHz receive band and a low-side mix is used for the 444-470 MHz receive band. For the high band UHF version, a high-side mix is used for the 450-455 MHz receive band and a low-side mix is used for the 455-520 MHz receive band. This band plan reduces the tuning range requirements for the VCOs.

A LO filter is used prior to LO port of the mixer to reduce the impact of wideband noise from the LO synthesizer on the receiver sensitivity.

IF Filter and Amplifier

A two-pole 64.455 MHz crystal filter (U2) is used to provide the desired level of adjacent channel

UHF RF BOARD (VERSION C)

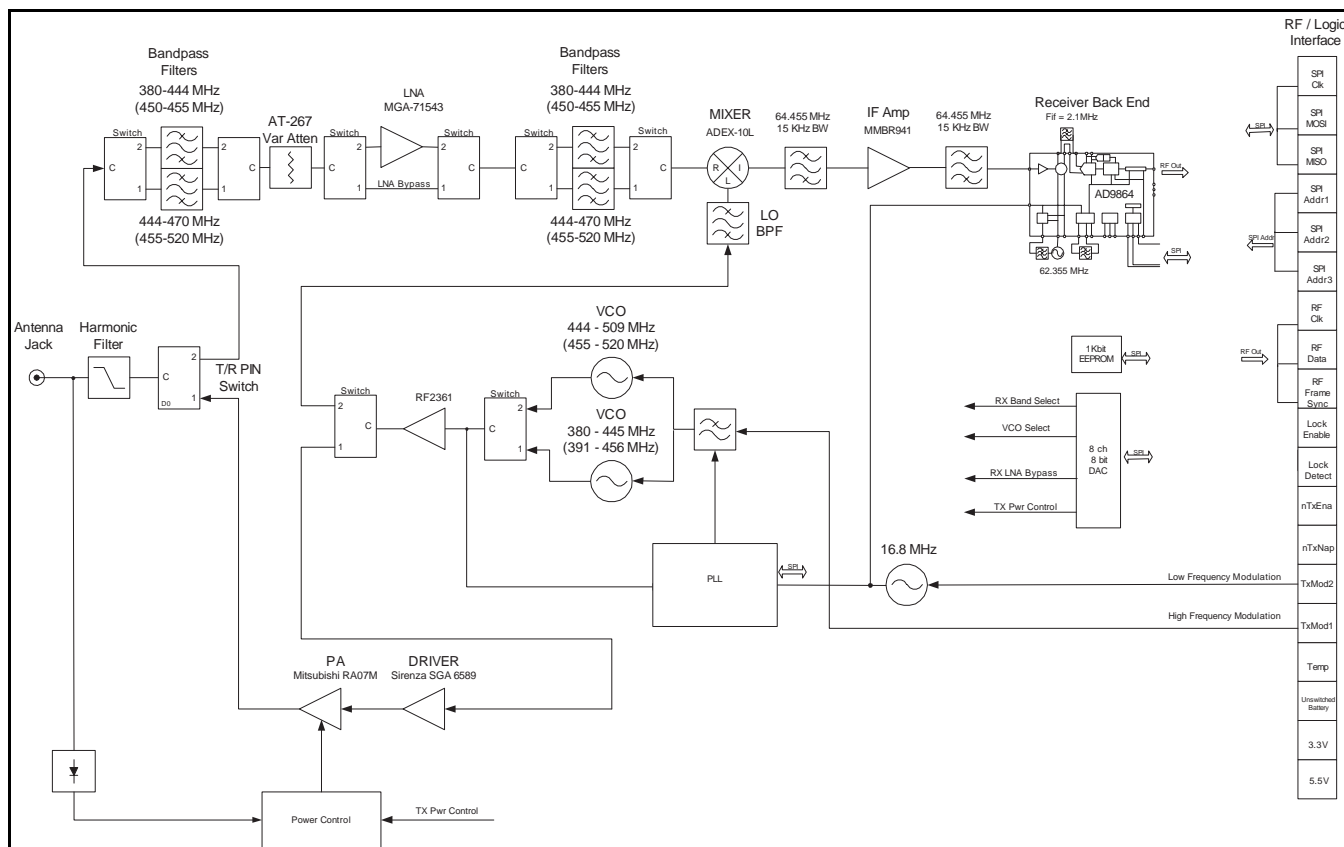


Figure 5-2 UHF RF Board Block Diagram (Version C)

rejection while providing minimal amplitude and phase distortion within a 25 KHz bandwidth. Shields installed around the crystal filter provide sufficient isolation to meet the second image response specifications and minimize noise pickup by the impedance-matching inductors (L1, L2, L3, L4 and L7.)

A transistor IF amplifier (Q1 and supporting circuitry) is required to boost the signal strength, thereby reducing the overall noise figure. The noise figure, signal gain, intercept point, and power consumption are optimized in this design. An additional two-pole 64.455 MHz crystal filter (U25) is used to increase the adjacent channel rejection. An LC circuit provides the required impedance matching between the output of the IF filter and the input of the backend chip (U11.)

Back End IC

An Analog Devices AD9864 IF Digitizing Subsystem IC (U11) provides a variety of functions for the receiver as follows:

Second Local Oscillator - A varactor-tuned transistor (Q2) oscillator is phase-locked to a fixed frequency of 62.355 MHz for converting the first IF of 64.455 MHz to a second IF frequency of 2.1 MHz. Phase Locked Loop circuitry inside of the AD9864 operates with a phase-detector frequency of 15 kHz.

Second Conversion Mixer and Filtering - A mixer inside the AD9864 converts from the first IF of 64.455 MHz to the second IF of 2.1 MHz. External filters (L29 and L30) provide IF bandpass filtering. Additional filtering is provided by the inherent operation of the sigma-delta analog/digital converters.

Gain Control - This device provides up to 12 dB of AGC range via a combination of analog and digital controls. Additionally, there is a 16 dB attenuator in the front end. The optimum settings are controlled by the host microprocessor.

UHF RF BOARD (VERSION C)

Analog / Digital Conversion and Processing - Sigma-delta converters provide I and Q sampling directly from the second IF frequency. The resulting digital words are first filtered by internal programmable FIR filters and then clocked out of the AD9864 via a serial data bus using a programmable data rate.

5.3.2 SYNTHESIZER

PLL IC

A CX72301 sigma-delta modulated PLL (U29) forms the basis of the main synthesizer that is used for both receive and transmit modes. This PLL chip provides good phase noise capabilities to reduce adjacent channel interference and quick switching between the receive and transmit modes.

In receive mode the PLL is programmed for a local oscillator frequency that is 64.455 MHz away from the receive frequency. In transmit mode the PLL is programmed directly for the transmit frequency.

Reference Oscillator

A 16.8 MHz oscillator (Y1) is used as the frequency reference to the synthesizer and also to the receiver backend IC. The center frequency of this oscillator is corrected using a DC tuning voltage from the digital board during receive and voice and data modulation during transmit.

Analog Switches and PLL Loop Filters

An analog switch (U17) provides quicker switching of signals during channel changes by varying the time constant of the PLL loop filter.

VCOs

Two different VCOs minimize the tuning range of the VCOs in order to meet phase noise specifications. Both VCO's (U1 and U5) are used for transmit and receive modes. Their combined tuning range covers the entire transmit and receive frequency bands. Transmit modulation is provided to each oscillator's modulation port from the digital board.

A RF2361 buffer amplifier (U6) provides the required level of drive for the receiver mixer's local oscillator signal as discussed above.

5.3.3 TRANSMITTER

Modulation

A "dual-port" modulation scheme is used in order to provide DC coupling of the signal required for data modulation applications. Modulation applied to the PLL's frequency reference provides low-frequency modulation, whereas modulation applied to the PLL's transmit VCO's (U1 and U5) provide high-frequency modulation. Signals for both modulation ports are provided from DACs on the digital board.

Power Amplifier

The power amplifier (U3) is a Mitsubishi RA07M4047M-01 module for the low band version and a Mitsubishi RA07M4452M-01 module for the high band version. The PA module provides the desired RF power output level and is stable over a wide range of VSWR conditions. The PA is driven by a SGA-6589 driver (U20) that typically provides +21 dBm output power. The PA is turned on and off by switching the power to this driver via transistor D10.

ALC

To maintain the specified Transmitter output power level, Automatic Level Control (ALC) is provided to control the drive level to the PA. The detected forward power is compared to a reference level provided by the digital board via op amp U21A. The resulting error voltage is applied to a power level control port of the power amplifier module. Transmitter on/off splatter filtering is provided by an RC network (R76, R109, C267 and C141.)

T/R Switching and Harmonic Filter

The output of the power amplifier is applied to the transmit/receive RF PIN switch (D12 & D13.) This is a high dynamic-range switch that is capable of passing the desired transmit power with minimal compression. Any harmonics generated by the PA module and the RF T/R switch are filtered by a harmonic filter that is between the RF T/R switch and the antenna jack.

700/800 MHz RF BOARD (VERSION C)

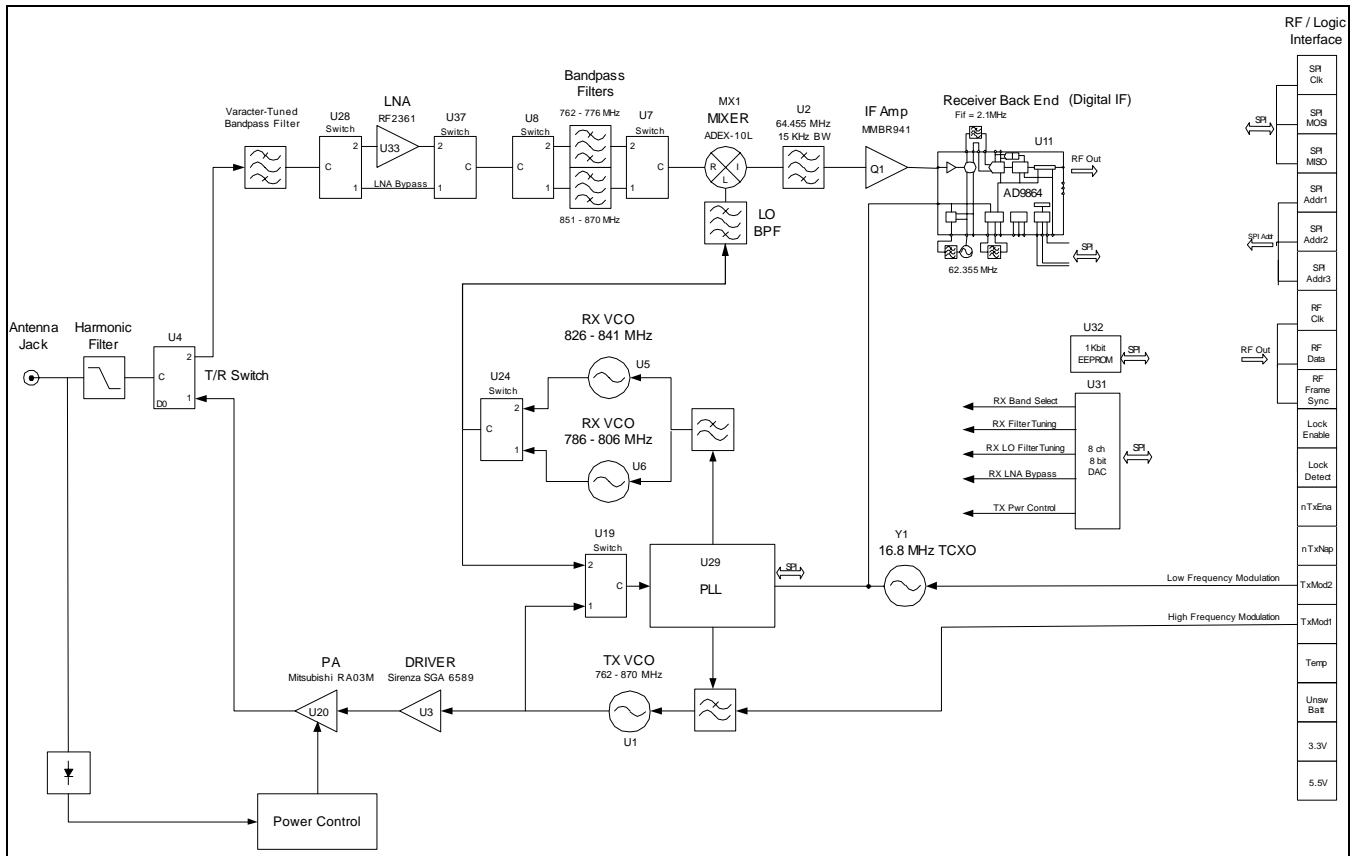


Figure 5-3 700/800 MHz RF Board Block Diagram

5.4 700/800 MHz RF BOARD (VERSION C)

NOTE: The following describes the new revised Version C RF board described in Section 1.13.1. The RF Board is not field serviceable. It must be replaced as a unit with a new board.

5.4.1 RECEIVER

Front End Bandpass Filter

A varactor-tuned bandpass filter (including W3 and W4) is used in the front-end of the receiver. This filter provides first-image rejection with minimal loss to provide the desired level of receiver sensitivity. The front-end bandpass filter center frequency is tuned via voltages from an 8-channel D/A converter. Ceramic resonators provide a high circuit Q and lower loss than a fixed inductor. A back-to-back varactor diode configuration increases the circuit's third-order intercept point.

Front End LNA and Bypass Switching

Low Noise Amplifier (LNA) U33 is critical in determining the overall noise figure of the receiver. The RF2361 amplifier provides a good noise figure, gain, intercept point and power consumption. RF switches U28 and U37 bypass the signal around the LNA when required to increase the effective third-order intercept point and the interference rejection capabilities of the receiver.

Post-LNA Bandpass Filters

Additional bandpass filters are used after the LNA. These filters are fixed-tuned since varactor-tuned filters would have an excessive third-order intercept point. One filter bank is tuned to the 700 MHz receive band and the other bank to the 800 MHz receive band. RF switches U8 and U7 select the desired band. These filters have better selectivity and more loss than the front-end filters, but the gain of the

700/800 MHz RF BOARD (VERSION C)

LNA minimizes the impact of the filter loss on the receiver sensitivity.

Mixer and LO Filter

A double-balanced, low-level ADEX-10L mixer (MX1) with a LO drive of +4 dBm is used for the first conversion. This mixer provides good dynamic range with 3 dB lower LO drive than the more traditional +7 dBm drive mixers. This provides power savings and reduces conducted and radiated LO leakage from the receiver. A high-side mix is used for the 700 MHz receive band and a low-side mix is used for the 800 MHz receive band. This band plan reduces the tuning range requirements for the VCOs.

A LO filter (including W1 and W2) is used prior to LO port of the mixer to reduce the effect of wide-band noise from the LO synthesizer on the receiver sensitivity. This filter is varactor-tuned with the center frequency tuned via a voltage from a D/A converter.

IF Filter and Amplifier

A four-pole 64.455 MHz crystal filter (U2) is used to provide the desired level of adjacent channel and image rejection while providing minimal amplitude and phase distortion within the 25 kHz bandwidth. Shields are installed around the crystal filter to provide sufficient isolation in order to meet the second image response requirements and minimize noise pickup by the impedance-matching inductors (L1, L2 and L7.)

A transistor IF amplifier (Q1 and supporting circuitry) is used to boost the signal strength which reduces the overall noise figure. The noise figure, signal gain, intercept point and power consumption are optimized by this circuit. An LC circuit provides the required impedance matching between the output of the IF amplifier and the input of backend chip U11.

Back End IC

An Analog Devices AD9864 IF Digitizing Subsystem IC (U11) provides the following receiver functions:

Second Local Oscillator - A varactor-tuned transistor (Q2) oscillator is phase-locked to a fixed

frequency of 62.355 MHz in order to convert the first IF of 64.455 MHz to a second IF frequency of 2.1 MHz. Phase Locked Loop circuitry inside of the AD9864 operates with a phase-detector frequency of 15 kHz.

Second Conversion Mixer and Filtering - A mixer inside the AD9864 converts from the first IF of 64.455 MHz to the second IF of 2.1 MHz. External filters L29 and L30 provide IF bandpass filtering. Additional filtering is provided by the inherent operation of the sigma-delta analog/digital converters.

Gain Control - This device provides up to 12 dB of AGC range via a combination of analog and digital controls. Additionally, there is a 16 dB attenuator in the front end. The optimum settings are controlled by the host microprocessor.

Analog/Digital Conversion and Processing - Sigma-Delta Converters provide I and Q sampling directly from the second IF frequency. The resulting digital words are first filtered by internal programmable FIR filters and then clocked out of the AD9864 via a serial data bus using a programmable data rate.

5.4.2 SYNTHESIZER

PLL IC

A CX72301 sigma-delta modulated PLL (U29) is used as the main receive and transmit synthesizer. This PLL chip provides exceptional phase noise capabilities to reduce adjacent channel interference and quick switching between the receive and transmit modes.

In the receive mode the PLL is programmed to a Local Oscillator frequency that is 64.455 MHz from the receive frequency. For the 700 MHz receive band, the LO frequency is higher than the receive frequency, and for the 800 MHz band, it is lower than the receive frequency. In transmit mode, the PLL is programmed directly to select the desired transmit frequency.

Reference Oscillator

A 16.8 MHz oscillator (Y1) provides the frequency reference for the synthesizer and receiver

700/800 MHz RF BOARD (VERSION C)

backend IC. The center frequency of this oscillator is corrected using a DC tuning voltage from the digital board during receive and it is modulated with voice or data during transmit.

Analog Switches and PLL Loop Filters

Analog switches U16, U17, and U18 provide faster channel switching by changing the time constant of the PLL loop filters.

VCOs

Three different VCOs are used. VCO U1 is used strictly in transmit mode. Its tuning range covers the entire transmit and receive frequency bands. Transmit modulation is provided to this oscillator's modulation port from the digital board through R9.

Two receive VCOs (U5 and U6) are required to meet the phase noise requirements. Each VCO functions for only one of the two receive bands. An RF2361 buffer amplifier (U40) provides the required level of drive for the receiver mixer's local oscillator signal as discussed above.

5.4.3 TRANSMITTER

Modulation

A “dual-port” modulation scheme is used to provide DC coupling of the signal for data modulation applications. Modulation applied to the PLL frequency reference provides low-frequency modulation, and modulation applied to the PLL transmit VCO (U1) provides high-frequency modulation. Signals for both modulation ports are provided from DACs on the digital board.

Power Amplifier

Power Amplifier U3 is a RA03M8087M module. It provides the desired RF power output level and is stable over a wide range of VSWR conditions. The PA is driven by a SGA-6589 driver (U20) that typically provides +21 dBm output power. The PA is turned on and off by switching the power to this driver via transistor D10.

RF BOARD OVERVIEW (VERSION A/B)

ALC

To maintain the specified Transmitter output power level, Automatic Level Control (ALC) is provided to control the drive level to the PA. The detected forward power is compared to a reference level provided by the digital board via op amp U21A. The resulting error voltage is applied to a power-level control port of the power amplifier module. Transmitter on/off splatter filtering is provided by RC network R63, R64, C141 and C211.

T/R Switching and Harmonic Filter

The output of the power amplifier is applied to transmit/receive RF switch U4. This is a high dynamic-range switch that is capable of passing the desired transmit power with minimal compression. Any harmonics generated by the PA module and the RF T/R switch are filtered by a harmonic filter that is between the RF T/R switch and the antenna jack.

5.5 RF BOARD OVERVIEW (VERSION A/B)

NOTE: The following describes the earlier Version A and B RF boards described in Section 1.13.1. The RF Board is not field serviceable. It must be replaced as a unit with a new board.

The receiver front end consists of a preselector, an RF amplifier, a second preselector, and a mixer (see Figure 5-4). With VHF and UHF models, both preselectors are varactor-tuned, two-pole filters controlled by the control logic. With 800 MHz models, these filters are fixed-tuned. The RF amplifier is a dual-gate, gallium-arsenide based IC. The mixer is a double-balanced, active mixer coupled by transformers. Injection is provided by the VCO through an injection filter. Refer to Table 5-1 for local oscillator (LO) and first IF information.

Table 5-1 LO and First IF Frequencies

| | VHF | UHF | 800 MHz |
|--------------------|---------------------|---------------------|---------------------|
| LO Frequency range | 181.15 - 219.15 MHz | 329.65 - 446.65 MHz | 776.65 - 796.65 MHz |
| First IF Frequency | 45.15 MHz | 73.35 MHz | 73.35 MHz |

VHF/UHF RF BOARD (VERSION A/B)

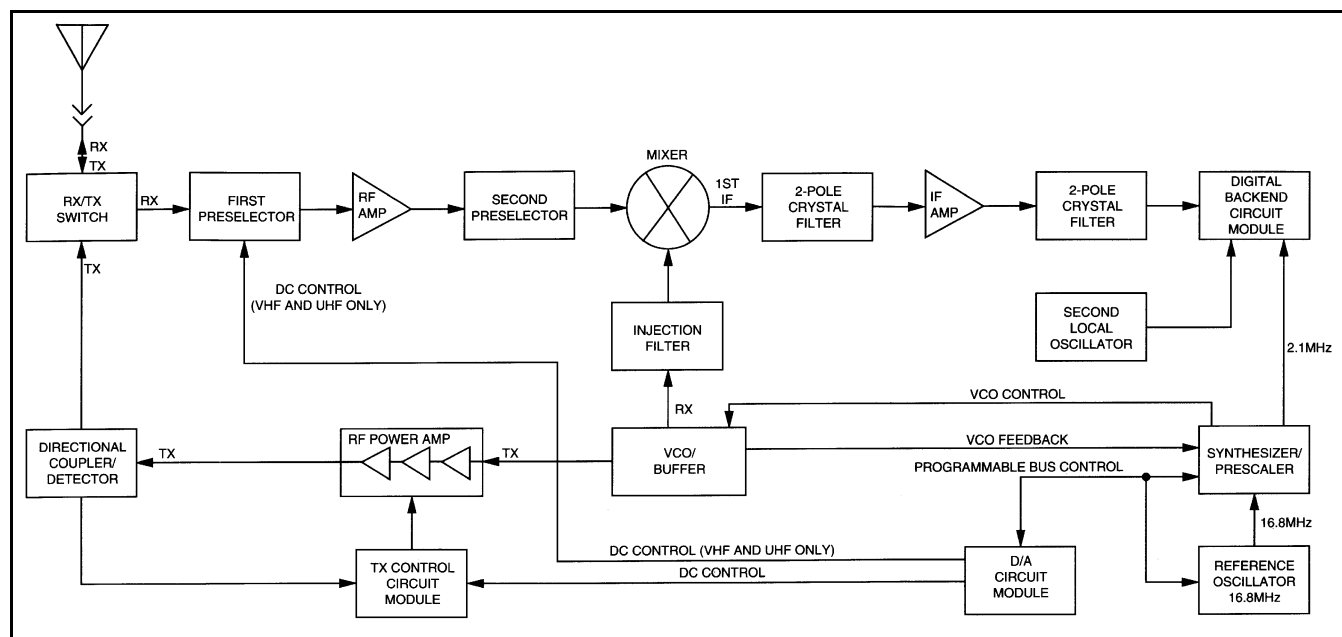


Figure 5-4 RF Board Block Diagram (Version A/B)

The frequency generation function is performed by three ICs and associated circuitry. The reference oscillator provides a frequency standard to the synthesizer/prescaler IC which controls the VCO IC. The VCO IC actually generates the first LO and transmit-injection signals and buffers them to the required power level. The synthesizer/prescaler circuit module incorporates frequency-division and comparison circuitry to keep the VCO signals stable. The synthesizer/prescaler IC is controlled by the control logic through a serial bus. Most of the synthesizer circuitry is enclosed in rigid metal cans to reduce microphonic effects.

The receiver back end consists of a two-pole crystal filter, an IF amplifier, a second two-pole crystal filter, and the digital back-end IC (ABACUS). The two-pole filters are wide enough to accommodate 5 kHz modulation. Final IF filtering is done digitally in the ADSIC.

The digital back-end IC (ABACUS) consists of an amplifier, the second mixer, an IF analog-to-digital converter, a baseband down-converter, and a 2.4 MHz synthesis circuit. The second LO is generated by discrete components external to the IC. The output of the ABACUS IC is a digital bit stream that is current driven on a differential pair for a reduction in noise generation.

The transmitter consists of an RF PA IC that gets an injection signal from the VCO. Transmit power is controlled by two custom ICs that monitor the output of a directional coupler and adjust PA control voltages correspondingly. The signal passes through a Rx/Tx switch that uses PIN diodes to automatically provide an appropriate interface to transmit or receive signals.

5.6 VHF/UHF RF BOARD (VERSION A/B)

NOTE: The following describes the earlier Version A and B RF boards described in Section 1.13.1.

5.6.1 FREQUENCY GENERATION UNIT (FGU)

The frequency generation unit (FGU) consists of three major sections: the high stability reference oscillator (U203), the fractional-N synthesizer (U204,) and the VCO buffer (U201). A 5V regulator (U202), supplies power to the FGU. The synthesizer receives the 5V REG at U204, and applies it to a filtering circuit within the module and capacitor C253. The well-filtered 5-volt output at U204, pin 19 is distributed to the Tx and Rx VCOs and the VCO buffer IC.

The mixer's LO injection signal and transmit frequency are generated by the Rx VCO and Tx VCO, respectively. The Rx VCO uses an external active

VHF/UHF RF BOARD (VERSION A/B)

device (Q202), whereas the VHF Tx VCO's active device is a transistor inside the VCO buffer. The UHF Tx VCO uses two active devices, one external (Q203) and the other internal to the VCO buffer. The base and emitter connections of this internal transistor are pins 11 and 12 of U201.

The Rx VCO is a Colpitts-type oscillator, with capacitors C235 and C236 providing feedback. The Rx VCO transistor (Q202) is turned on when pin 38 of U204 switches from high to low. The Rx VCO signal is received by the VCO buffer at U201, pin 9, where it is amplified by a buffer inside the IC. The amplified signal at pin 2 is routed through a low-pass filter (L201 and associated capacitors) and injected as the first LO signal into the mixer (U2, pin 8). In the VCO buffer, the Rx VCO signal (or the Tx VCO signal during transmit) is also routed to an internal prescaler buffer. The buffered output at U201, pin 16 is applied to a low-pass filter (L205 and associated capacitors). After filtering, the signal is routed to a prescaler divider in the synthesizer at U204, pin 21.

The divide ratios for the prescaler circuits are determined from information stored in memory during programming. The microcontroller extracts data for the division ratio as determined by the selected channel and sends that information to a comparator in the synthesizer via a bus. A 16.8 MHz reference oscillator, U203, applies the 16.8 MHz signal to the synthesizer at U204 pin 14. The oscillator signal is divided into one of three pre-determined frequencies. A time-based algorithm is used to generate the fractional-N ratio.

If the two frequencies in the synthesizer's comparator differ, a control (error) voltage is produced. The phase detector error voltage (V control) at pins 31 and 33 of U204 is applied to the loop filter consisting of resistors R211, R212, and R213, and capacitors C244, C246, C247, and C248. The filtered voltage alters the VCO frequency until the correct frequency is synthesized. The phase detector gain is set by components connected to U204, pins 28 and 29.

In the Tx mode, U204, pin 38 goes high and U201, pin 14 goes low, which turns off transistor Q202 and turns on the internal Tx VCO transistor in U204 and the external Tx VCO buffer Q203 on the UHF

circuit. The Tx VCO feedback capacitors are C219 and C220. Varactor diode CR203/CR207 sets the Tx frequency while varactor CR202 is the Tx modulation varactor.

The modulation of the carrier is achieved by using a two-port modulation technique. The modulation of low frequency tones is achieved by injecting the tones into the A/D section of the fractional-N synthesizer. The digitized signal is modulated by the fractional-N divider, generating the required deviation. Modulation of the high-frequency audio signals is achieved by modulating the varactor (CR203) through a frequency compensation network. Resistors R207 and R208 form a potential divider for the higher-frequency audio signals.

In order to cover the very wide bandwidths, positive and negative V-control voltages are used. High control voltages are achieved using positive and negative multipliers. The positive voltage multiplier circuit consists of components CR204, C256, C257, and reservoir capacitor C258. The negative multiplier circuit consists of components CR205, CR206, C266, C267, and reservoir capacitor C254.

Out-of-phase clocks for the positive multiplier appear at U204, pins 9 and 10. Out-of-phase clocks for the negative multiplier appear at U204, pins 7 and 8, and only when the negative V-control is required (that is, when the VCO frequency exceeds the crossover frequency). When the negative V-control is not required, transistor Q201 is turned on, and capacitor C259 discharges. The 13V supply generated by the positive multiplier is used to power-up the phase detector circuitry. The negative V-control is applied to the anodes of the VCO varactors.

The Tx VCO signal is amplified by an internal buffer in U201, routed through a low pass filter and routed to the Tx PA module, U105, pin 1. The Tx and Rx VCOs and buffers are activated via a control signal from U204, pin 38.

The reference oscillator supplies a 16.8 MHz clock to the synthesizer where it is divided down to a 2.1 MHz clock. This divided-down clock is fed to the ABACUS IC (U401), where it is further processed for internal use.

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5.6.2 ANTENNA SWITCH

The antenna switch is a current device consisting of a pair of diodes (CR108/ CR109) that electronically steer RF between the receiver and the transmitter. In the transmit mode, RF is routed through transmit switching diode CR108, and sent to the antenna. In the receive mode, RF is received from the antenna, routed through receive switching diode CR109, and applied to the RF amplifier Q1 (VHF) or U1 (UHF). In transmit, bias current, sourced from U101, pin 21, is routed through L105, U104, CR108, and L122 (VHF) and L105, CR108, and L122 (UHF). Sinking of the bias current is through the transmit ALC module, U101, pin 19. In the receive mode, bias current, sourced from switched B+, is routed through Q107 (pin 3 to pin 2), L123 (UHF), L121, CR109, and L122. Sinking of the bias current is through the 5-volt regulator, U106, pin 8.

5.6.3 RECEIVER FRONT END

The RF signal is received by the antenna and coupled through the external RF switch. The UHF board applies the RF signal to a low-pass filter consisting of L126, L127, L128, C149, C150, and C151. The VHF board bypasses the low-pass filter. The filtered RF signal is passed through the antenna switch (CR109) and applied to a bandpass filter consisting of (VHF) L11 - L14, CR1 - CR9, C4, C2, and C3 or (UHF) L30, L31, L32, L34, L35, CR6 - CR9, C1, C2, and C3. The bandpass filter is tuned by applying a control voltage to the varactor diodes in the filter (CR1 - CR9 VHF and CR6 - CR9 UHF).

The bandpass filter is electronically tuned by the D/A IC (U102), which is controlled by the microcomputer. The D/A output range is extended through the use of a current mirror consisting of Q108 and R115 and R116. When Q108 is turned on via R115, the D/A output is reduced due to the voltage drop across R116. Depending on the carrier frequency, the microcomputer will turn Q108 on or off. Wideband operation of the filter is achieved by retuning the bandpass filter across the band.

The output of the bandpass filter is applied to wideband GaAs RF amplifier IC U1 (UHF) or active device Q1 (VHF). The RF signal is then further

filtered by a second broadband, fixed-tuned, bandpass filter consisting of C6, C7, C8, C80, C86, C87, C88, C97, C99, L3, L4, L5, and L30 (VHF) or C4 -C7, C88 - C94, C99, and L11 - L15 (UHF) to improve the spurious rejection.

The filtered RF signal is routed through a broadband 50-ohm transformer (T1) to the input of a broadband mixer/buffer (U2). Mixer U2 uses GaAs FETs in a double-balanced, Gilbert Cell configuration.

The RF signal is applied to the mixer at U2 pins 1 and 15. An injection signal (1st LO) of about -10 dBm supplied by the FGU is applied to U2, pin 8. Mixing of the RF and the 1st LO results in an output signal that is the first IF frequency. The first IF frequency is 45.15 MHz for the VHF band and 73.35 for the UHF band. High side injection is used for VHF and low side for UHF. The first IF signal output at U2, pins 4 and 6 is routed through transformer T2 and impedance matching components, and applied to a two-pole crystal filter (FL1), which is the final stage of the receiver front end. The two-pole crystal filter removes unwanted mixer products. Impedance matching between the output of the transformer (T2) and the input of the filter (FL1) is accomplished by C605 and L605 (VHF) or C611, C614, and L605 (UHF).

5.6.4 RECEIVER BACK END

The output of crystal filter FL1 is matched to the input of IF buffer amplifier transistor Q601 by C610 and L604 (VHF) and C609, C610, and L600 (UHF). Transistor Q601 is biased by the 5V regulator (U202). The IF frequency on the collector of Q601 is applied to a second crystal filter through a matching circuit. The second crystal filter (FL2) input is matched by C604, C603, and L601 (VHF) and C604, L601, and L602 (UHF). The filter supplies further attenuation at the IF sidebands to increase the radios selectivity. The output of FL2 routed to pin 32 of U401 through a matching circuit which consists of L603, L606, and C608 (VHF) and L603, C606, and C605 (UHF).

In the ABACUS IC (U401), the first IF frequency is amplified and then down-converted to the second IF frequency of 450 kHz. At this point, the analog signal is converted into two digital bit streams by a sigma-delta A/D converter. The bit streams are then digitally

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filtered, mixed down to baseband, and filtered again. The differential output data stream is then sent to the logic board where it is decoded to produce the recovered audio.

The ABACUS IC (U401) is electronically programmable. The amount of filtering, which is dependent on the radio channel spacing and signal type, is controlled by the microcontroller. Additional filtering, which used to be provided externally by a conventional ceramic filter, is replaced by internal digital filters in the ABACUS IC. The ABACUS IC contains a feedback AGC circuit to expand the dynamic range of the sigma-delta converter. The differential output data contains the quadrature (I and Q) information in 16-bit words, the AGC information in a 9-bit word, imbedded word sync information, and fill bits dependent on sampling speed. A fractional N synthesizer is also incorporated on the ABACUS IC for 2nd LO generation.

The 2nd LO/VCO is a Colpitts oscillator built around transistor Q401 (VHF) or Q1 (UHF). The VCO has a varactor diode, VR401 (VHF) or CR5 (UHF) to adjust the VCO frequency. The control signal for the varactor is derived from a loop filter consisting of C426, C428, and R413.

5.6.5 TRANSMITTER

The transmitter consists of three major sections:

- Harmonic Filter
- RF Power Amplifier Module
- ALC Circuits

Harmonic Filter

With VHF versions, RF from PA module U105 is routed through coupler U104 and passed through the harmonic filtering network to antenna switch CR108. With UHF versions, RF from the PA module U105 is routed through coupler U104 and passed through transmit antenna switch CR108 and applied to a harmonic filtering network. The harmonic filtering circuit is composed of (VHF) L126, L127, L128, C149, C150, and C151 or (UHF) L126, L127, L128, C129, C130, C149, C150, and C151. Resistor R117 (VHF) or R117 (UHF) provides a current-limited 5V to J2.

RF Power Amplifier Module

RF power amplifier module U105 is a wide-band, three-stage (VHF) or four-stage (UHF) amplifier. Nominal input and output impedance of U105 is 50 ohms. The DC bias for U105 is on pins 2, 4, 5. In the transmit mode, the voltage on U105, pins 2 and 4 (close to the B+ level) is obtained via switching transistor Q101. Transistor Q101 receives its control base signal as follows:

- The microcomputer keys the D/A IC to produce a ready signal at U 102 pin 3,
- the ready signal at U102 pin 3 is applied to the Tx ALC IC at U101 pin 14 (5V), and
- the synthesizer sends a LOC signal to the Tx ALC IC (U204 pin 40 to U101 pin 16).

When the LOC signal and the ready signal are both received, the Tx ALC IC (pin 13) sends a control signal to turn on transistor Q101.

ALC Circuits

Coupler module U104 samples the forward and reverse power of the PA output voltage. Reverse power is present when there is other than 50 ohms impedance at the antenna port. Sampling is achieved by coupling some of the forward and/or reverse power, and applying it to CR102 (VHF) or CR101 (UHF) and CR103 for rectification and summing. The resultant DC signal is then applied to the Tx ALC IC (U101, pin 2) as RFDET to be used as an RF strength indicator.

The transmit ALC circuit, built around U101, is the heart of the power control loop. Circuits in the Tx ALC module compare the signals at U101, pins 2 and 7. The resultant signal, C BIAS, at U101, pin 4 is applied to the base of transistor Q110. In response to the base drive, transistor Q110 varies the DC control voltages applied to the RF PA at U105, pin 3, thus controlling the RF power of module (U105).

Thermistor RT101 senses the temperature of the Tx ALC IC. If an abnormal operating condition exists that causes the PA temperature to rise to an unacceptable level, the thermistor forces the ALC to reduce the set power.

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5.7 800 MHz RF BOARD (VERSION A/B)

NOTE: The following describes the earlier Version A and B RF boards described in Section 1.13.

5.7.1 FREQUENCY SYNTHESIS

The complete synthesizer subsystem consists of the reference oscillator (U304), the voltage-controlled oscillator (VCO U307), a buffer IC (U303), and the synthesizer (U302).

The reference oscillator contains a temperature-compensated 16.8 MHz crystal. This oscillator is digitally tuned and contains a temperature-referenced, five-bit, analog-to-digital (A/D) converter. The output of the oscillator (pin 10 on U304) is applied to pin 14 (XTAL1) on U302 through capacitor C309 and resistor 8306.

Voltage-controlled oscillator module U307 is varactor tuned. Therefore, as the voltage being applied to pins 1 and 7 of the VCO varies (2-11V), so does the varactor's capacitance which changes the VCO output frequency. The 800 MHz VCO is a dual-range oscillator that covers the 806-825 MHz and the 851-870 MHz frequency bands.

The low-band VCO (777-825 MHz) provides the first LO injection frequencies (777-797 MHz) that are 73.35 MHz below the carrier frequency. In addition, in the transmit mode when the radio is operated through a repeater, the low-band VCO generates the transmit frequencies (806-825 MHz) that are 45 MHz below the receiver frequencies. The low band VCO is selected by pulling pin 3 high and pin 8 low on U307. When radio-to-radio or talk-around operation is necessary, the high band VCO (851-870 MHz) is selected. This is accomplished by pulling pin 3 low and pin 8 high on U307.

The buffer IC (U303) includes a Tx, Rx, and prescaler buffer which maintain a constant output level and provides isolation. The Tx buffer is selected by setting pin 7 of U303 high, and the Rx buffer is selected by setting pin 7 of U303 low. The prescaler buffer is always on. In order to select the proper combination of VCO and buffer, the following conditions must be true at pin 6 of U303 (or pin 38 of U302) and pin 7 of U303 (or pin 39 of U302):

- For first LO injection frequencies 777-797 MHz, pins 6 and 7 must both be low.
- For Tx repeater frequencies 806-825 MHz, pins 6 and 7 must both be high.
- For talk-around Tx frequencies 851-870 MHz, pin 6 must be low and pin 7 must be high.

The synthesizer IC (U302) consists of a prescaler, a programmable loop divider, a divider control logic, a phase detector, a charge pump, an A/D converter for low-frequency digital modulation, a balance attenuator to balance the high-frequency analog modulation to the low-frequency digital modulation, a 13V positive-voltage multiplier, a serial interface for control, and finally, a filter for the regulated 5-volt supply. This filtered five volts is present at pin 19 of U302, pin 9 of U307, and pins 2, 3, 4, and 15 of U303. It is also applied directly to resistors R309, R315, and R311. Additionally, the 13V supply generated by the positive voltage multiplier circuitry should be present at pin 35 of U302. The serial interface (SRL) is connected to the microprocessor via the data line (pin 2 of U302), clock line (pin 3 of U302), and chip-enable line (pin 4 of U302).

The complete synthesizer subsystem operates as follows:

- The output of the VCO, pin 4 on U307, is fed into the RF input port (pin 9) of U303. In the Tx mode, the RF signal is present at pin 4 of U303; in the RX mode, the RF signal is present at pin 3 of U303.
- The output of the prescaler buffer, pin 15 of U303, is applied to the PREIN port (pin 21) of U302. The prescaler in U302 is a dual modulus type with selectable divider ratios. This divider ratio is controlled by the loop divider, which in turn receives its inputs from the SRL. The loop divider adds or subtracts phase to the prescaler divider by changing the divide ratio via the modulus control line.
- The output of the prescaler is then applied to the loop divider.
- The output of the loop divider is then applied to the phase detector. The phase detector compares the

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loop divider's output signal with the signal from U304 (that is divided down after it is applied to pin 14 of U302). The result of the signal comparison is a pulsed DC signal which is applied to the charge pump.

- The charge pump outputs a current that is present at pin 32 of U302. The loop filter (which consists of capacitors C322, C317, C318, C329, C324, and C315, and resistors R307, R305, and R314) transforms this current into a voltage that is applied to pins 1 and 7 of U307 to alter the VCO's output frequency.

In order to modulate the PLL, the two-port modulation method is utilized. The analog modulating signal is applied to the A/D converter as well as the balance attenuator, via U302, pin 5. The A/D converter converts the low-frequency analog modulating signal into a digital code that is applied to the loop divider, thereby causing the carrier to deviate. The balance attenuator is used to adjust the VCO's deviation sensitivity to high-frequency modulating signals.

5.7.2 ANTENNA SWITCH

An electronic PIN diode switch steers RF between the receiver and transmitter. The common node of the switch is at capacitor C101. In the transmit mode, RF is routed to the anode of diode CR104. In receive mode, RF is routed to pin 1 of U201. In the transmit mode, bias current sourced from U504, pin 21, is routed through PIN diodes CR104 and CR102 which biases them to a low-impedance state. Bias current returns to ground through U504, pin 20. In receive, U504, pin 21, is pulled down to ground and pin 20 is pulled up to B+ which reverse-biases diodes CR104 and CR102 to a high impedance.

5.7.3 RECEIVER FRONT END

The 800 MHz receiver front end converts the received RF signal to the first IF frequency of 73.35 MHz and also provides spurious immunity and adjacent channel selectivity. The received RF signal is passed through antenna switch input matching components C101, L105, and C114, through tank components C106 and L103 (which are anti-resonant at the radios transmitter frequencies), and through output matching components C103 and L104. Both pin

diodes CR102 and CR104 must be back-biased to properly route the received signal.

The stage following the antenna switch is a 50-ohm, inter-digitated, three-pole, stripline preselector (U201). The preselector is positioned after the antenna switch to provide the receiver preamp with some protection against strong, out-of-band signals.

After the preselector (U201), the received signal is processed through receiver preamp U202. The preamp is a dual-gate, GaAs MESFET transistor which has been internally biased for optimum IM, NF, and gain performance. Components L201 and L202 match the input (gate 1) of the amp to the first preselector, while at the same time connecting gate 1 to ground potential. The output (drain) of the amp is pin 7, and is matched to the subsequent receiver stage by L204 and C222. A supply voltage of 5V DC is provided to pin 3 through RF choke L203 and bypass capacitor C204. The 5-volt supply is also present at pin 4, which connects to a voltage divider network that biases gate 2 (pin 5) to a predefined quiescent voltage of 1.2V DC. Resistor R202 and capacitor C203 are connected to pin 5 to provide amp stability. The FET source (pin 3) is internally biased at 0.55 to 0.7VDC for proper operation with bypass capacitors C201 and C202, connected to the same node.

The output of the amp is matched to a second three-pole preselector (U203) of the type previously discussed. The next stage in the receiver chain is first mixer U205 which uses low-side injection to convert the RF carrier to an intermediate frequency (IF) of 73.35 MHz.

Since low-side injection is used, the LO frequency is offset below the RF carrier by 73.35 MHz, or $f_{LO} = f_{RF} - 73.35 \text{ MHz}$. The mixer utilizes GaAs FETs in a double-balanced, Gilbert Cell configuration. The LO port (pin 8) incorporates an internal buffer and a phase shift network to eliminate the need for a LO transformer. The LO buffer bypass capacitors (C208, C221, and C216) are connected to pin 10 of U205, and should exhibit a nominal DC voltage of 1.2 to 1.4V DC. Pin 11 of U205 is LO buffer Vdd (5V DC), with associated bypass capacitors C226 and C209 connected to the same node. An internal voltage divider network within the LO buffer is bypassed to virtual ground at pin 12 of U205 through bypass

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capacitor C213. The mixer's LO port is matched to the radio's PLL by a capacitive tap, C207 and C206.

A balun transformer (T202) is used to couple the RF signal into the mixer. The primary winding of T202 is matched to the preceding stage by capacitor C223, with C227 providing a DC block to ground. The secondary winding of T202 provides a differential output, with a 180° phase differential being achieved by setting the secondary center tap to virtual ground using bypass capacitors C210, C211, and C212. The secondary of transformer T202 is connected to pins 1 and 15 of the mixer IC, which drives the source leg of dual FETs used to toggle the paralleled differential amplifier configuration within the Gilbert Cell.

The final stage in the receiver front end is a two-pole crystal filter (FL1). The crystal filter provides some of the receiver's adjacent channel selectivity. The input to the crystal filter is matched to the first mixer using L605, C600, and C614. The output of the crystal filter is matched to the input of IF buffer amplifier transistor Q601 by L600, C609, and C610.

5.7.4 RECEIVER BACK END

The IF frequency on the collector of Q601 is applied to a second crystal filter (FL2) through a matching circuit consisting of L601, L602, C604, and C612. The filter supplies further attenuation at the IF sidebands to increase the radio's selectivity. The output of FL2 is routed to pin 32 of U401 through a matching circuit consisting of L603, C603, and C606, and DC blocking capacitor C613.

In the ABACUS IC (U401), the first IF frequency is amplified and then down-converted to the second IF of 450 kHz. The analog signal is then converted into two digital bit streams by a sigma-delta A/D converter. The bit streams are then digitally filtered, mixed down to baseband, and filtered again. The differential output data stream is then sent to the ADSIC on the logic board, where it is decoded to produce the recovered audio.

The ABACUS IC (U401) is electronically programmable. The amount of filtering is dependent on the radio channel spacing and signal type, and is controlled by the microcomputer. Additional filtering, which used to be provided externally by a conventional ceramic filter, is replaced by internal digital

filters in the ABACUS IC. The ABACUS IC contains a feedback AGC circuit to expand the dynamic range of the sigma-delta converter. The differential output data contains the quadrature (I and Q) information in 16-bit words, the AGC information in a 9-bit word, imbedded word sync information, and fill bits which are dependent on sampling speed. A fractional N synthesizer is also incorporated on the ABACUS IC for 2nd LO generation.

The second LO/VCO is a Colpitts oscillator built around transistor Q1. The VCO has a varactor diode (VR401), which is used to adjust the VCO frequency. The control signal for the varactor is derived from a loop filter consisting of C426, C428, and R413.

5.7.5 TRANSMITTER

The 800 MHz RF power amplifier (PA) is a five-stage amplifier (U502). The RF power amplifier has a nominal input and output impedance of 50 ohms.

An RF input drive level of approximately +3 dBm, supplied from the VCO buffer IC (U303), is applied to pin 1 of U502. The DC bias for the internal stages of U502 is applied to pins 3 and 4 of the module. Pin 3 is switched through Q502 and pin 4 is unswitched B+ to the final amplifier stage. Power control is achieved by varying of the DC bias to pin 2, the third and fourth amplifier stages of the module. The amplified RF signal leaves the PA module at pin 5 and is applied to the directional coupler (U501).

The purpose of U501 is to sample both the forward power and the reverse power. Reverse power is present when a load other than 50 ohms exists at the antenna port. The sampling is achieved by coupling some of the reflected power, forward and/or reverse, to a coupled leg on the coupler. The sampled RF signals are applied to diode CR501 for rectification and summing. The resultant DC signal is applied to the ALC IC (U504, pin 2) as RFDET, to be used as an indicator of the strength of the RF signal being passed through the directional coupler (U501).

The transmit ALC IC (U504) is the main part of the power control loop. The REF V line (U504 pin 7), a DC signal supplied from the D/A IC (U503), and the RF DET signal described earlier, are compared internally in the ALC IC to determine the amount of C BIAS, pin 4, to be applied to the base of transistor

UI BOARD (ALL VERSIONS)

Q501. Transistor Q501 responds to the base drive level by varying the DC control voltages applied to pin 2 of the RF PA which controls the RIF power level of module U502. The ALC IC also controls the base switching to transistor Q502 via pin 12, BIAS.

The D/A IC (U503) controls the DC switching of the transceiver board. Its outputs, SC1 and SC3 (pins 12 and 14, respectively), control transistor Q503 which then supplies Tx 5V and Rx 5V to the transceiver board. The D/A also supplies DC bias to the detector diode (CR501) via pin 7, and the REF V signal to the ALC IC (U504).

5.8 USER INTERFACE BOARD (ALL)

NOTE: The following describes all three logic versions described in Section 1.13.

5.8.1 INTRODUCTION

The User Interface Board contains the main microcontroller which controls all functions of the transceiver. In addition, it contains memory (Flash, SRAM, and EEPROM), A-D and D-A converters, the interface to the graphic display, audio circuitry, and various other interfaces.

5.8.2 MICROCONTROLLER (U2)

Microcontroller U2 is PowerPC[®] based which gives this transceiver processing power equal to some current desktop computers. This microcontroller provides all transceiver control functions except signal processing which is provided by the DSP U1 on the logic board.

Functions provided by U2 include detecting key and button presses, processing incoming and outgoing calls, displaying operational data to the user, and coordinating control of the other processor (DSP) located on the logic board. Communication with the DSP is via a 16-bit host port.

The operating speed of U2 is controlled by 4.9152 MHz crystal Y1. The internal clock is five times this frequency or 24.575 MHz (25 MHz operational).

5.8.3 MEMORY

Early Units (Versions A and B in Section 1.13)

Memory devices include Flash, SRAM, EEPROM, and DSP SRAM. There is 4 megabyte of Flash that is used primarily for code storage but can also be used for as non-volatile memory.

The SRAM (static RAM) consists of one 256K x 16 and one 512K x 16 device (U2 and U3), each of which used a different chip select. A 32K x 8 EEPROM (U16) is used to store personality data.

Later Units (Version C in Section 1.13)

Memory devices include Flash, SRAM, EEPROM, and DSP SRAM. There is 8 megabyte of Flash that is used primarily for code storage but can also be used for as non-volatile memory.

The SRAM (static RAM) consists of a 1M x 16 device (U6). A 32K x 8 EEPROM (U16) is used to store personality data.

5.8.4 GRAPHICAL DISPLAY

The graphical display is connected to J4. This type of display allows text and icons to be positioned anywhere on the display and allows text to be displayed in various fonts (type styles).

5.9 LOGIC BOARD (VERSION C)

NOTE: The following describes the Version C logic board described in Section 1.13.

5.9.1 INTRODUCTION

The Digital Signal Processing (DSP) functions are performed by the DSP chip (U15) and the CODEC (U27) with the support of microcontroller U1 on the UI board. Functions previously performed in hardware like filtering and limiting are performed by software running in the DSP chip.

LOGIC BOARD (VERSION C)**5.9.2 DIGITAL SIGNAL PROCESSING OVERVIEW**

The DSP section consists of a DSP chip (U15) and the CODEC (U27). The CODEC is a support chip for the DSP. It provides the interface between the DSP and the analog signal paths, and between the DSP and the Digital IF chip on the RF Board. Configuration of the Digital IF chip is handled primarily by microcontroller U2.

In receive mode, the DSP interfaces with the Digital IF chip IC on the RF Board. The DSP collects the I and Q samples from the Digital IF chip and performs channel filtering and frequency discrimination on the signals. The resulting demodulated signal is routed to the DSP via the serial port for further processing. After the DSP processing, the signal is sent to the CODEC Speaker D/A by writing to a memory-mapped register. The CODEC then converts the processed signal from the DSP to an analog signal and then outputs this signal to a single ended to differential converter (U8A/D). It is then routed to the UI board, amplified, and then sent to the speaker.

In transmit mode the microphone signal is converted to a differential signal on the UI board and then routed to logic board, converted back to single ended, and then applied to the CODEC and digitized by an internal A/D converter. The DSP reads these values from a memory-mapped register in the CODEC. After processing, the DSP sends the modulation signal to the CODEC via the serial port. In the CODEC, the VCO D/A converts the sampled modulation signal into an analog signal and then routes this signal to the VCO on the RF Board.

5.9.3 RECEIVE SIGNAL PATH

The Digital IF chip on the RF Board provides a digital back end for the receiver section. It provides a digital output of I (in phase) and Q (quadrature) samples which represent the IF signal at the receiver back end. These samples are routed to the DSP where the signal is filtered and frequency discriminated to recover the modulating signal.

LOGIC BOARD (VERSION A/B)**5.10 LOGIC BOARD (VERSION A/B)**

NOTE: The following describes the Version A and B logic board described in Section 1.13.

5.10.1 INTRODUCTION

The Digital Signal Processing (DSP) functions are performed by the DSP chip (U1) and the ADSIC (U2) with the support of microcontroller U1 on the UI board. Functions previously performed in hardware like filtering and limiting are performed by software running in the DSP chip.

5.10.2 DIGITAL SIGNAL PROCESSING OVERVIEW

The DSP section consists of a DSP chip (U1) and the ADSIC (U2). The ADSIC is a support chip for the DSP. It provides the interface between the DSP and the analog signal paths, and between the DSP and the ABACUS chip on the RF Board. Configuration of the ADSIC is handled primarily by microcontroller U2. The DSP has access to a few memory-mapped registers on the ADSIC.

In receive mode, the ADSIC interfaces the DSP with the ABACUS IC on the RF Board. The ADSIC collects the I and Q samples from the ABACUS and performs channel filtering and frequency discrimination on the signals. The resulting demodulated signal is routed to the DSP via the serial port for further processing. After the DSP processing, the signal is sent to the ADSIC Speaker D/A by writing to a memory-mapped register. The ADSIC then converts the processed signal from the DSP to an analog signal and then outputs this signal to a single ended to differential converter (U8A/B). It is then routed to the UI board, amplified, and then sent to the speaker.

In transmit mode the microphone signal is converted to a differential signal on the UI board and then routed to logic board, converted back to single ended, and then applied to the ADSIC and digitized by an internal A/D converter. The DSP reads these values from a memory-mapped register in the ADSIC. After processing, the DSP sends the modulation signal to the

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ADSIC via the serial port. In the ADSIC, the VCO D/A converts the sampled modulation signal into an analog signal and then routes this signal to the VCO on the RF Board.

5.10.3 RECEIVE SIGNAL PATH

The ABACUS IC on the RF Board provides a digital back end for the receiver section. It provides a digital output of I (in phase) and Q (quadrature) samples which represent the IF signal at the receiver back end. These samples are routed to the ADSIC where the signal is filtered and frequency discriminated to recover the modulating signal.

The recovered signal is sent to the DSP chip for processing. The ADSIC interface to the ABACUS is comprised of four signals SBI, DIN, DIN*, and ODC.

SBI is a programming data line for the ABACUS. This line is used to configure the operation of the ABACUS and is driven by the ADSIC. Microcontroller U2 programs many of the ADSIC operational features through the SPI interface. There are 36 configuration registers in the ADSIC of which 4 contain configuration data for the ABACUS. When these particular registers are programmed by the microcontroller, the ADSIC in turn sends this data to the ABACUS through the SBI.

DIN and DIN* are the data lines in which the I and Q data words are transferred from the ABACUS. These signals make up a differentially encoded current loop. Instead of sending TTL-type voltage signals, the data is transferred by flowing current one way or the other through the loop. This helps reduce internally generated spurious emissions on the RF Board. The ADSIC contains an internal current loop decoder which translates these signals back to TTL logic and stores the data in internal registers.

The ODC signal is a clock the ABACUS provides to the ADSIC. Most internal ADSIC functions are clocked by this ODC signal at a rate of 2.4 MHz and are available as soon as the power is supplied to the circuitry. This signal initially may be 2.4 or 4.8 MHz after power-up. It is programmed by the ADSIC through the SBI signal to 2.4 MHz when the ADSIC is initialized by the microcontroller through the SPI bus. For any functionality of the ADSIC to exist, including

initial programming, the reference clock must be present.

In the fundamental operating mode, the ADSIC transfers raw IF data to the DSP. The DSP then performs IF filtering and discriminator functions to produce a baseband demodulated signal. However, the ADSIC also includes a digital IF and discriminator function and can provide a baseband demodulated signal directly to the DSP. This is typically what occurs. The digital IF filter is programmable by the microcontroller with up to 24 taps.

The DSP processes this data through the SSI serial port. This is a six-port synchronous serial bus. The ADSIC transfers the data on the TxD line to the DSP at a rate of 2.4 MHz. This is clocked synchronously by the ADSIC which provides a 2.4 MHz clock on SCKT. In addition, a 20 kHz interrupt is provided on TFS to signal the arrival of a data packet. This means a new I and Q sample data packet is available to the DSP at a 20 kHz rate which represents the sampling rate of the received data. The DSP then processes this data to extract audio, signaling, and other information based on the 20 kHz interrupt.

In addition to the SPI programming bus, the ADSIC also contains a parallel configuration bus. This bus is used to access registers mapped into the DSP memory. Some of these registers are used for additional ADSIC configuration controlled directly by the DSP. Some of the registers are data registers for the speaker D/A. Analog speaker audio is processed through this parallel bus where the DSP outputs the speaker audio digital data words to this speaker D/A. In addition, an analog waveform is generated which is output to SDO (Speaker Data Out).

In conjunction with speaker D/A, ADSIC contains a programmable attenuator to set the rough signal attenuation. However, the fine levels and differences between signal types are adjusted through the DSP software algorithms. The speaker D/A attenuator setting is programmed by the microcontroller through the SPI bus.

The ADSIC provides an 8 kHz interrupt to the DSP on IRQB for processing the speaker data samples. This 8 kHz signal must be enabled through the SPI programming bus by the microcontroller and is necessary for any audio processing to occur.

LOGIC BOARD (VERSION A/B)**5.10.4 TRANSMIT SIGNAL PATH**

The ADSIC contains an analog-to-digital (ADC) converter for the microphone. The microphone path in the ADSIC also includes an attenuator that is programmed by the microcontroller through the SPI bus. The microphone input in the ADSIC is on pin MAI (U2-75). The microphone ADC converts the analog signal to a series of data words and stores them in internal registers. The DSP accesses this data through the parallel data bus. As with the speaker data samples, the DSP reads the microphone samples from registers mapped into its memory space. The ADSIC provides an 8 kHz interrupt to the DSP on IRQB for processing the microphone data samples.

The DSP processes these microphone samples and generates and mixes the appropriate signaling and filters the resultant data. This data is then transferred to the ADSIC on the DSP SSI port. The ADSIC generates a 48 kHz interrupt so that a new sample data packet is transferred at a 48 kHz rate and sets the transmit data sampling rate at 48 ksps. These samples are then input to a transmit D/A which converts the data to an analog waveform. This waveform is the modulation signal from the ADSIC and is connected to the VCO on the RF Board.

5.10.5 ADSIC (U2)

The ADSIC is a complex custom IC which performs many analog-to-digital, digital-to-analog, and purely digital functions as previously described. The ADSIC has four internal registers accessible by the DSP. Two of these registers are read-only while the two others are write-only. Therefore, they can be accessed as two locations in the I/O spaces.

Crystal Y1 along with the internal oscillator in the ADSIC provide a 20 MHz clock. This clock signal

is used internally by the ADSIC and is also multiplied by two to provide a 40 MHz clock to the DSP. The frequency of the clock can be electronically shifted a small amount by controlling varicap D1 through the OSCW pin (U2-16). This removes interference created on some channels by the clock.

The ADSIC and DSP exchange the sampled receive data and the sampled VCO modulation signal

AUDIO CIRCUIT (VERSION A/B)

through a serial port. This serial port consists of pins SCKR, RFS, RxD, TxD, SCKT, and TFS on the ADSIC.

SDO is the output of the internal speaker DAC. MAI is the input of the internal microphone attenuator and is followed by the microphone ADC.

The ADSIC is configured partially by the DSP through its data and address bus. However, most of the configuring is provided through an SPI compatible serial bus. This SPI serial bus consists of pins SEL*, SPD, and SCLK.

5.11 AUDIO CIRCUIT (VERSION A/B)

NOTE: The following describes the Version A and B logic described in Section 1.13.

5.11.1 RECEIVE AUDIO CIRCUIT

NOTE: A block diagram of the audio circuit is shown in Figure 5-5.

In receive mode, the analog receive waveform created by ADSIC U2 (on the Logic Board) is fed out of that device on the SDO (Signal Data Out) pin. It is then converted to a differential signal by U8C and U8D to minimize noise. The signal is then fed to the UI board on the Audio_Out_P/M lines and converted back to a single-ended signal by U17B. It is then combined by U17C with any tones from U17A and applied to the audio amplifiers.

Audio amplifier U8 provides amplification for the internal 8-ohm speaker and U21 provides amplification for an external speaker-microphone connected to pins 2 and 6 of the accessory (UDC) connector. U8 and U21 provide 750 mW of power with an 8-ohm load.

The gain of U8 and U21 is controlled by the DC voltage on the Vin (3) pin. When this pin is grounded by mute switches Q10 or Q2, no output is produced. Gain then increases as this DC voltage increases. The volume control signal is produced as follows:

The top panel volume control produces a varying DC voltage that is buffered by U20 on the UI board. This voltage is then applied to A/D converter U9 and

converted to serial data which is fed to microcontroller U1. This allows the microcontroller to determine the volume level that is currently set by the user.

Q8 is connected to the Head Phone Sense pin (2) of amplifier U21. When Q8 is turned off by the nSEOP signal, pin 2 goes high and U21 switches from the differential to the single-ended output mode. This allows an external speaker-microphone to be connected from pin 7 to ground instead of across pins 7 and 5.

NOTE: A block diagram of the audio circuit is shown in Figure 5-5.

Analog switch U24 selects either the internal or external microphone signal, depending on the logic level on the CS input. The internal microphone NC pin (4) is selected when CS is low and the external microphone NO (6) is selected when it is high. Q6 provides inversion and buffering of the SRC_SEL signal.

The single-ended microphone signal is then converted to a differential signal by U19A and U19D to reduce noise. It is then fed to the logic board on the AUDIO_IN_P/M lines, converted back to a single-ended signal by U8C and U8D, and applied to the MAI (Microphone Audio In) pin of ADSIC U2.

SECTION 6 ALIGNMENT PROCEDURE

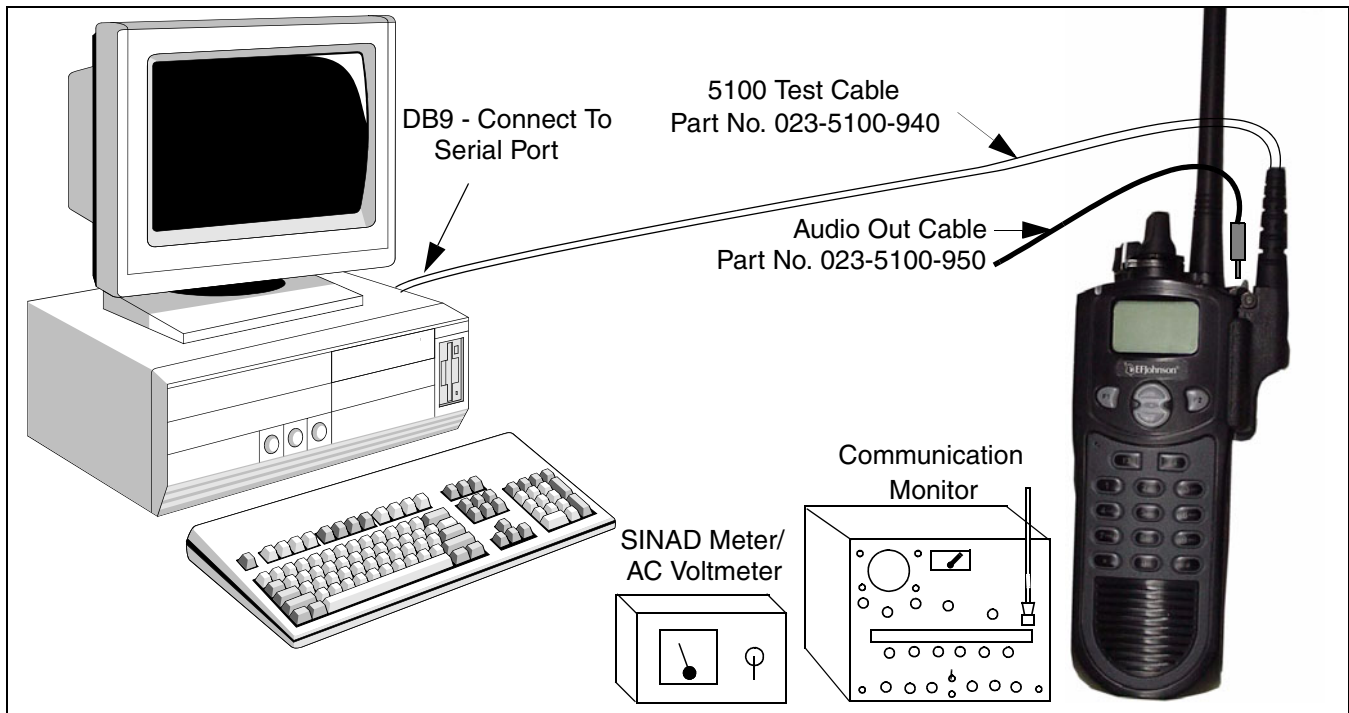


Figure 6-1 Alignment Setup

6.1 GENERAL

6.1.1 INTRODUCTION

The following alignment procedure should be performed if repairs are made that could affect the factory alignment or if adjustments may have changed for some other reason. To verify radio operation, the performance tests in Sections 6.5 and 6.6 can be run.

To perform transceiver alignment and performance tests, the following are required:

- PCTune Kit, Part No. 250-5100-005. This kit includes the –940 test cable, –950 audio cable, and –499 PCTune software and this manual on a CD-ROM.
- SMA (F) to BNC (F) adapter, Part No. 515-3102-050, to connect test equipment to antenna jack.
- To operate the radio with the front cover assembly unplugged from the chassis, use UI - Logic Extension Test Cable, Part No. 023-5100-955.

All adjustments are set digitally using the computer. Therefore, there is no need to disassemble the transceiver to access adjustment points. In addition, audio test signals are generated internally, so an audio generator is not required. The required test equipment is shown in Figure 6-1.

6.1.2 TUNE SOFTWARE

General

The PCTune software is a Windows® program. Minimum software and hardware requirements are as follows:

- Windows® 95/98/NT/2000 (3.1 cannot be used)
- Pentium® processor or equivalent
- 16 MB of RAM
- A hard disk drive with at least 3 MB of free space
- A CD-ROM drive
- An available serial port

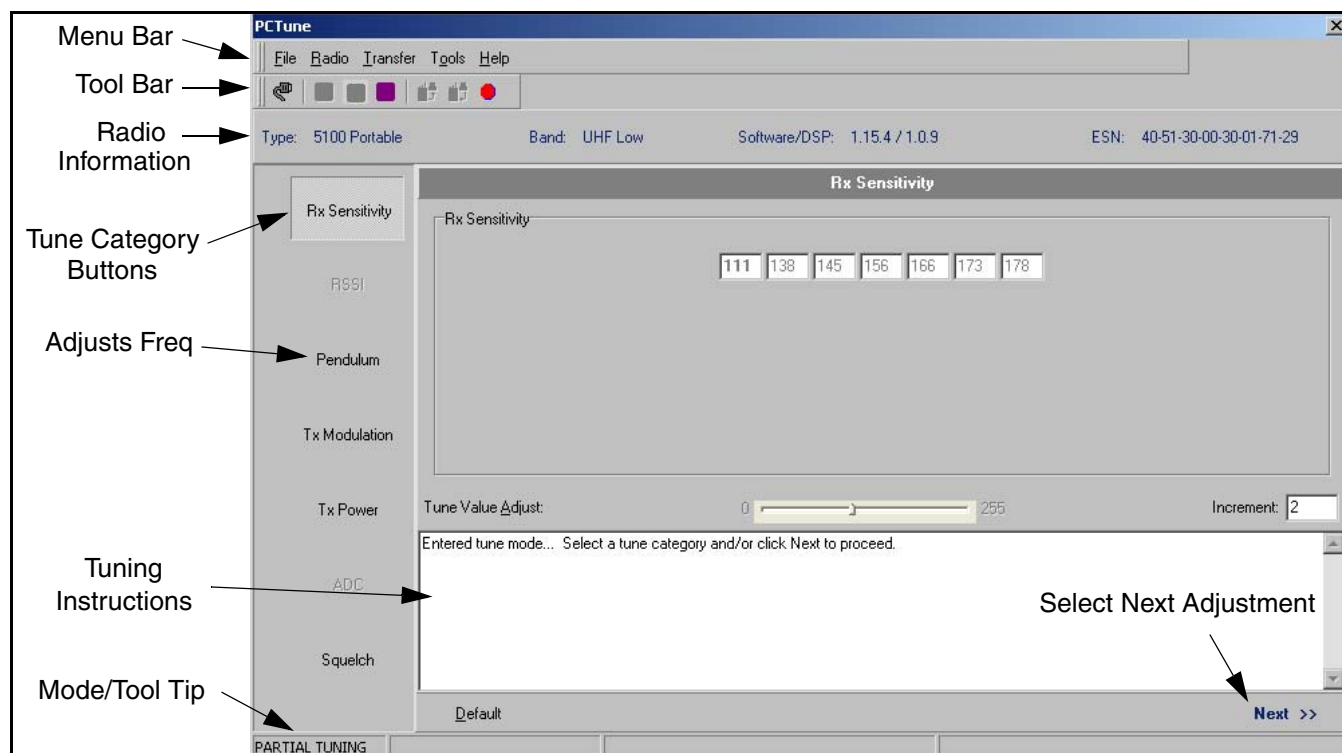


Figure 6-2 PCTune Main Screen (Version 2.0)

Software Installation


Proceed as follows to install this software:

1. Close all applications that are currently running (other than Windows).
2. Insert the CD-ROM containing the PCTune software into the drive.
3. From the Windows taskbar, choose RUN and open SETUP.EXE on the drive being used. Alternatively, use File Explorer and double click SETUP.EXE.
4. Follow the instructions on the screen. The program is automatically loaded on the hard drive and start-up shortcuts or groups are created.

Starting PCTune

Select Start in the taskbar, then Programs > PCTune > PCTune.

Exiting PCTune

Select File > Exit or click the  button.

On-Line Help

On-line help is currently not available.

6.1.3 PCTUNE VERSION REQUIRED

PCTune, Version 2.0.0 or later is required to tune radios with the Version C RF board (see Section 1.13.1). The PCTune version number can be displayed by selecting the Help > About menu. This information describes Version 2.0.0. Earlier versions have a different main screen, but function similarly.

6.2 MAIN SCREEN






The main PCTune screen is shown in Figure 6-2. Information on the various parts of this screen follows:

Menu Bar - Used to select the menus described in Sections 6.3.1-6.3.5.


Tool Bar - These buttons are used to quickly select functions as follows:



- Displays the screen used to set serial port parameters (see Section 6.3.3).

-  - Selects the Partial Tune mode the same as the Transfer > Tune Partial menu (see Section 6.3.3) This mode allows manual selection of the desired Tune Category and then automatically steps through the various settings for that adjustment.
-  - Selects the Edit Mode which allows parameters in the selected screen to be changed without stepping through each adjustment.
-  - Reads and displays the current parameters programmed in the radio the same as the Radio > Read Tune Parameters menu (see Section 6.3.3).
-  - Writes the current tune parameters to the radio the same as the Transfer > Write Tune Parameters menu (see Section 6.3.3). This occurs automatically when a Partial Tune adjustment is completed.
-  - Exits the current Tune Category without writing parameters to the radio.

Radio Information

When tuning parameters are read from a radio by clicking the  button or selecting the Transfer > Read Parameters menu, the following information is displayed in the top part of the screen:

Type - The Radio Series selected by the Radio menu (see Section 6.3.2). The correct series must be selected for communication with the radio to occur.

Band - The radio frequency band of the radio displayed after information is read from radio. Do not select the band using Tools > Set Band (Section 6.3.4) because this may make the radio nonfunctional.

Software DSP - The first number is the version number of the radio firmware (Flash/operating code), and the second number is the version number of the DSP software.

ESN - The Electronic Serial Number electronically stored in the radio.

Tuning Categories

These buttons select the tuning adjustment to be performed. Different functions are displayed for the 51xx and 53xx. If the Partial tune mode is selected, these buttons select the particular adjustment that is performed.

Mode/Tool Tip

Information on the bottom line of the screen indicates the current tune mode and information on the selected button on other information.

6.3 MENU BAR DESCRIPTION

6.3.1 FILE MENU

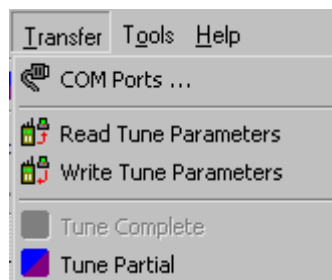
Selecting File > Exit closes the PCTune program.

6.3.2 RADIO MENU



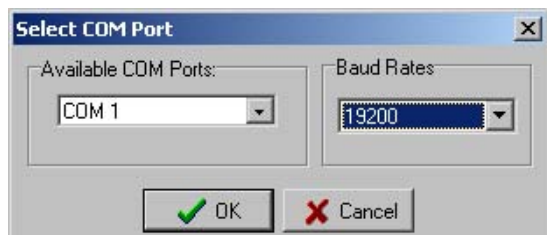
The Radio menu shown above selects the radio type. Also select “5100” for the 51SL and Ascend portable, and also select “5300” for the 53SL and Ascend mobile. The correct radio type must be selected for communication with the radio to occur.


6.3.3 TRANSFER MENU




COM Ports - Displays the following screen which selects the serial port (1-12) and baud rate (9600/19200) used for communication with the radio. Select the computer port to which the test cable is connected (see Section 6.4.1), and 19200 baud is normally

selected. These parameters default to the last selected condition the next time the program is started.




Read Tune Parameters - Selecting this function or clicking the  button reads the tune parameters currently programmed in the transceiver and displays them in the various screens.

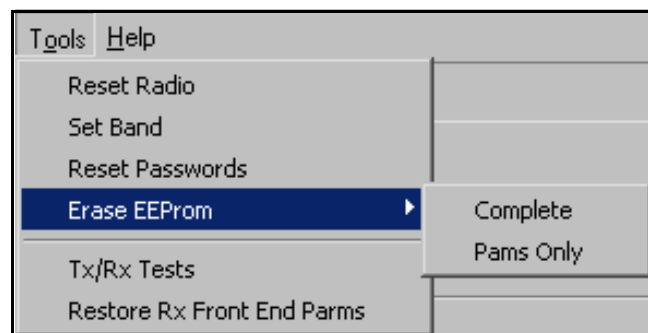
NOTE: Values in the various screens are for reference only and adjustments should be done only by using the Partial Tune function.

Write Tune Parameters - Selecting this function or clicking the  button writes the current tune parameters to the radio. This occurs automatically when a Partial Tune adjustment is completed.

Tune Complete - Currently not available. This function automatically steps through all the tests required to tune the radio.

Tune Partial - Selecting this function or clicking the  button selects the Partial Tune mode. This mode automatically steps through all the adjustments of the currently selected Tune Category.

6.3.4 TOOLS MENU



Reset Radio - Resets the radio control logic similar to cycling power. This can be used, for example, to

change the radio series or band or exit an adjustment before it is complete.

Set Band - Selects the operating band of the radio. All tuning values are reset to the factory defaults.

CAUTION: Do not select this function because it can make the radio non-functional.

Reset Passwords - Erases all password information contained in the radio. This function can be used, for example, to allow reprogramming of passwords if they are lost. *NOTE: Radio personality information is not erased by this function.*

Erase EEPROM

CAUTION: This function erases important radio programming information as described below.

Complete - Erases all EEPROM information, including factory programmed parameters.

CAUTION: Do not select this function because the radio must be returned to the factory to make it operational again.

Parms Only - Erases all personality information.

NOTE: The radio must be reprogrammed after this function is selected.

Tx/Rx Tests - Selects a screen which is used to check digital (P25) receive and transmit performance. Refer to Section 6.5 for more information.

Restore Rx Front End Parameters - Programs the radio with default receive front end tune parameters. Other parameters remain unchanged.

6.3.5 HELP MENU

Displays the version number of the PCTune software and other information.

6.4 TUNING PROCEDURE

6.4.1 CONNECTING TEST SETUP

1. With transceiver power turned off, connect the –940 test cable to an unused serial port of the computer (see Section 6.1). The –920 programming cable (see

Section 4) should not be used because it does not have the audio output jack.

2. Connect the other end of the test cable to the accessory (UDC) jack of the transceiver (see Figure 6-1).
3. If the receiver squelch adjustment will be made, connect a SINAD meter to the Audio Out jack of the test cable (see Figure 6-1). This is a 2.6 mm (3/32") mono phone jack. *NOTE: The audio output signal at this jack is a single-ended speaker-microphone signal and therefore at a lower level than the differential signal fed to a speaker-microphone. Refer to "Audio Power Output and Distortion" in Section 6.6.2 for more information.*
4. Connect a wattmeter and a suitable load to the antenna jack of the transceiver for the transmitter tests (an SMA to BNC adapter is listed in Section 6.1.1). For the receiver tests, connect the signal generator to the antenna jack through a 6 dB or greater isolation pad.

6.4.2 STARTING AND CONFIGURING PCTUNE

1. Start the program as described in Section 6.1.2 and turn transceiver power on. Select Transfer > COM Port and make sure that the correct serial port and the 19200 baud rate are selected (see Section 6.3.3).
2. Select the Radio menu and make sure the correct radio series (51xx) is selected (see Section 6.3.2).
3. Select Transfer > Partial Tune and click the button for the desired Test Category.
4. Follow the instructions displayed on the screen to complete the various adjustments required for a particular setting. Then repeat for other applicable Test Categories. (The "Pendulum" test sets the TCXO frequency.)

6.5 DIGITAL PERFORMANCE TESTS

6.5.1 GENERAL

This section describes how to check the performance of the radio on digital Project 25 channels. The PCTune software includes a Tools > Tx/Rx Tests menu that displays the screen used for these tests.

- To perform these tests, a Digital Communication Analyzer such as Motorola R2670 or IFR 2975 is required.
- These tests follow the TIA-102-CAAA-A "Digital C4FM/CQPSK Transceiver Measurement Methods" specification. Refer to that document for more information.
- A P25 conventional channel preprogrammed by the PCConfigure software is used for testing. The PCTune software does not select a specific test channel. The test channel must be programmed with the following options:

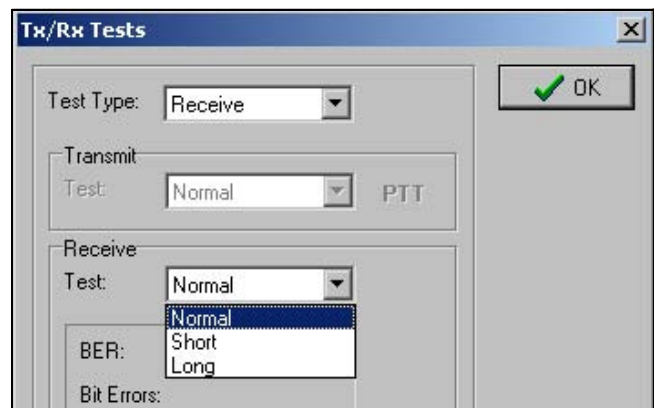
NAC - 293 (hex)

TGID (Talk Group ID) - 1

Frequency - Any frequency in radio operating band

6.5.2 RECEIVE TEST SETUP

1. Connect the test setup and start and configure the PCTune software as described in Section 6.4. Select the Tools > Tx/Rx Tests menu to display the Tx/Rx Tests screen. Then in the Test Type drop-down list select Receive to display the following screen.



2. Connect the Digital Communication Monitor to the antenna jack using a 6 dB or greater isolation pad. Set the Monitor output for the "1011" test pattern.

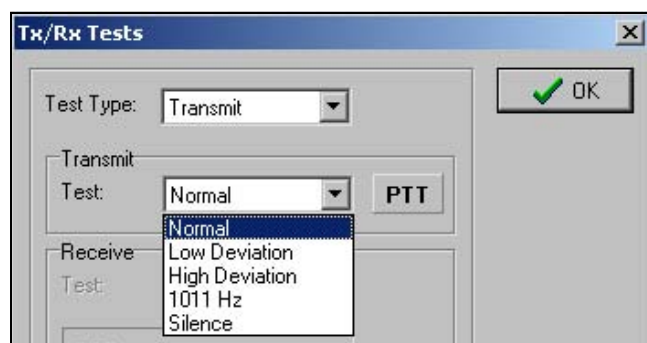
6.5.3 RECEIVE SENSITIVITY TEST

1. A tone should be heard from the radio speaker if the analyzer is set properly. Select the "Short" or "Long" test in the Test drop down list and the radio should mute.

- Set the analyzer output level for $0.35\ \mu\text{V}$ ($-116\ \text{dBm}$) at the receiver antenna jack. The BER (Bit Error Rate) should be 5% or less. (This is a ratio of the receive bit errors to the total number of bits transmitted.)
- Increase the analyzer output level to $1000\ \mu\text{V}$ ($-47\ \text{dBm}$). The BER rate should be less than 0.01%. This is the BER Rate Floor.

6.5.4 TRANSMITTER TESTS

- If applicable select the Tools > Tx/Rx Tests menu to display the Tx/Rx Tests screen. Then in the Test Type drop-down list select Transmit to display the following screen. Connect a dummy load to the radio antenna jack. Monitor the transmit signal with the Digital Communication Monitor.



- Select the **Low Deviation** test and set the analyzer as required to measure transmitter deviation. This test generates continuous repetitions of bits 10100000. Deviation should be 848-1037 Hz.
- Click the “PTT” button to transmit the tone. When finished, click that button again to turn the transmitter off.
- Select the “**High Deviation**” test which transmits a standard transmitter test pattern. Deviation should be 2544-3111 Hz.
- The “**1011 Hz**” test transmits a standard 1011 Hz tone similar to that used for the receiver test. This tone can be used to check the operation of other radios.
- The “**Silence**” test transmits a standard silence test pattern which produces no receive audio output by

the receiving radio. This tone can also be used to test other radios.

- Select “**Normal**” to transmit a standard voice signal by speaking into the radio microphone.

6.6 ANALOG PERFORMANCE TESTS

6.6.1 GENERAL

The PCTune software is not used for analog channel performance testing. Simply program the desired channels using the PCConfigure software as described in Section 4. The test cable is still required to monitor the audio output signal from the radio.

Depending on the application, 12.5 kHz, 25 kHz, and (800 MHz) NPSPAC test channels may need to be programmed. Also, test channels programmed with or without Call Guard[®] (CTCSS/DCS) squelch control may be required.

6.6.2 RECEIVER PERFORMANCE TESTS

- Connect a signal generator to the antenna jack using a 6 dB or greater pad. Set the output for the channel frequency, modulated with 1 kHz at the following deviation:

12.5 kHz Channels - 1.5 kHz

25 kHz Channels - 3.0 kHz

800 MHz NPSPAC Channels - 2.4 kHz

- Connect a 16-ohm speaker load to the audio output jack of the test cable (see Figure 6-1). Connect a SINAD meter across the speaker load. See “Audio Power Output and Distortion” which follows for more information.

SINAD Sensitivity

- Set the signal generator output level for $1000\ \mu\text{V}$ ($-47\ \text{dBm}$) at the antenna jack. Adjust the radio volume control to mid range.
- Decrease the signal generator output to obtain 12 dB SINAD. The signal generator output should be $0.35\ \mu\text{V}$ ($-116\ \text{dBm}$) or less for 25 kHz channels, or $0.50\ \mu\text{V}$ ($-113\ \text{dBm}$) or less for 12.5 kHz channels.

Squelch Sensitivity

5. Increase the signal generator output from zero and note the SINAD when unsquelching occurs. It should be approximately 8 dB.

Audio Power Output and Distortion

CAUTION: Test equipment connected across speaker leads must be floating because grounding either lead could damage the radio. This does not apply to the test cable audio jack (see following information).

The internal speaker and external speaker-microphone are driven by separate audio amplifiers as follows:

Internal Speaker - The internal speaker does not have an external output. To measure the power and distortion of its amplifier, the meter must be connected across the speaker terminals (Extension Test Cable, Part No. 023-5100-955, is then be required to operate the radio). This output is rated for 0.5 watt (2.83 V rms) across a 16-ohm load and distortion should be less than 5%.

External Speaker-Mic - The external speaker-microphone amplifier outputs are pins 2 and 6 of the accessory connector. This output is rated for 0.4 watt (2.52 V rms) across a 16-ohm load.

Test Cable Audio Jack - This jack provides a single ended low-level audio output by tapping one of the external speaker-mic outputs. This allows the sleeve side of this jack to be connected to ground, but it does not provide the high-level output required to check rated audio power output.

6.6.3 TRANSMITTER PERFORMANCE TESTS

1. Connect a wattmeter and dummy load to the antenna jack. Monitor the transmit signal with a communication monitor.

Transmit Frequency

2. Monitor the transmit frequency and at room temperature it should ± 100 Hz. At other temperatures (-30 to $+60^{\circ}$ C), it must be within 2.5 PPM (VHF/UHF) or 1.5 PPM (800 MHz). This also checks the receive frequency.

Transmit Power

3. Transmit power should be as follows in the high and low power modes:

VHF Models - 5W high, 1W low

UHF Models - 4W high, 1W low

700 MHz Mod. - 2.5W high/TA, 1W low

800 MHz Models - 3W std/2.5W TA high, 1W low

Tolerance for all: -0 W, $+0.5$ W high, ± 0.1 W low

Transmit Modulation

4. Monitor the transmit modulation with a modulation meter. Speak into the microphone with a normal voice. Modulation should be approximately as follows with no CTCSS/DCS signaling present:

12.5 kHz Channels - 1.4 kHz

25 kHz Channels - 3.4 kHz

800 MHz NPSPAC Channels - 2.5 kHz

5. Select a channel programmed with Call Guard (CTCSS/DCS) signaling. Maximum total Call Guard and voice modulation should be approximately as follows:

12.5 kHz Channels - 2.3 kHz

25 kHz Channels - 4.7 kHz

800 MHz NPSPAC Chan - 3.8 kHz

SECTION 7 PARTS LIST

| Ref No. | Description | Part No. |
|--------------------------------|-------------------------------------------------------------------------------------------------|--------------|
| CHASSIS, HARDWARE, MISC | | |
| A 030 | Rear housing assembly, std version | 023-5100-030 |
| | Rear housing assembly, UCM ver includes CH 030, J 030 | 023-5100-032 |
| A 035 | Battery contact assembly | 585-5100-017 |
| A 040 | Top switch assembly (includes EP101b, EP102, MP40, PC40, R101, S101) | 023-5100-040 |
| A 050 | Front cover assembly (includes MP101, MP109, MP111, MP114, MP115, MP116, Limited keypad version | |
| | Black standard | 023-5100-054 |
| | Yellow standard | 023-5100-051 |
| | Orange standard | 023-5100-052 |
| | Black UCM models* | 023-5100-056 |
| | Yellow UCM models* | 023-5100-057 |
| | Orange UCM models* | 023-5100-058 |
| | DTMF keypad version | |
| | Black standard | 023-5100-065 |
| | Yellow standard | 023-5100-061 |
| | Orange standard | 023-5100-062 |
| | Black UCM models* | 023-5100-066 |
| | Yellow UCM models* | 023-5100-067 |
| | Orange UCM models* | 023-5100-068 |
| A 100 | Logic board assembly (see version info in Section 1.13) | |
| | EFJ SEM, Version C (see separate listing on page 7- 2) | 023-5500-120 |
| | No module, Version A | 023-5100-110 |
| | EFJ SEM, Version B | 023-5100-150 |
| | Mot UCM, Version B (see separate listing on page 7- 5) | 023-5100-160 |
| A 200 | RF module, complete w/flex, clip (see Section 1.13 for version info) | |
| | VHF, Version C | 585-5500-100 |
| | UHF 380-470 MHz, Version C | 585-5500-300 |
| | UHF 450-512 MHz, Version C | 585-5500-300 |
| | 700/800 MHz, Version C | 585-5500-700 |

| Ref No. | Description | Part No. |
|---------|-----------------------------------------------------------------------|--------------|
| | VHF 134-174 MHz, Version B | 023-5110-001 |
| | UHF 380-450 MHz, Version B | 023-5120-001 |
| | UHF 403-470 MHz, Version B | 023-5130-001 |
| | UHF 450-512 MHz, Version B | 023-5140-001 |
| | 800 MHz, Version B | 023-5180-001 |
| A 400 | User interface (UI) board assembly (see version info in Section 1.13) | |
| | EFJ SEM, Version C (see separate listing on page 7- 8) | 023-5500-420 |
| | No module, Version A | 023-5100-410 |
| | EFJ SEM, Version B | 023-5100-450 |
| | Mot UCM, Version B (see sep listing on page 7- 12) | 023-5100-460 |
| A 401 | Backlight assembly, fiber optic | 585-5100-013 |
| CH 030 | Rear housing, metalized std | See A 030 |
| | Rear housing, modified for UCM | See A 030 |
| DS 401 | LCD assembly, 49 x 96 fsn | 549-5000-005 |
| EP 030 | Flexible EMI gasket | 574-3500-001 |
| EP 031 | Urethane foam, 1/4" x 1.2" x 1.9" | 018-1007-250 |
| EP 101b | Seal, top switch | 574-3500-071 |
| EP 102 | Seal, top switch | 574-3500-071 |
| HW 031 | O-ring, .301 antenna connector | 574-2510-001 |
| HW101 | Nut, spanner M6-.75-6h (w/o HW105) | 013-1313-005 |
| | Nut, spanner (w/ HW105) | 013-1313-007 |
| HW 102 | Nut, spanner M6-.75-6h | 013-1313-005 |
| HW 103 | Screw, #1-32 plastite 7/32" | 575-5601-007 |
| HW 105 | Washer, nylon, volume control | 596-9405-015 |
| J 030 | Antenna connector, SMA press fit | See A 030 |
| MK 101 | Microphone cartridge | 589-0301-003 |
| MP 003 | Accessory (UDC) jk water barrier | 574-3500-073 |
| MP 006 | Light pipe | 032-0431-194 |
| MP 007 | Light pipe sleeve | 032-0431-195 |

* Refer to Section 1.13 for UCM information.

CHASSIS, HARDWARE, MISC (Cont'd)

| Ref No. | Description | Part No. |
|------------------------------------------------------------------------------------|--------------------------------------------------------|----------------|
| MP 030 | RF shield, improved Ver A/B bds | 017-2229-552 |
| | RF shield, Version C RF boards (see Section 1.13.1) | 017-2229-569 |
| MP 031 | Logic shield, non-UCM versions | 017-2229-553 |
| | Logic shield, UCM versions | 017-2229-556 |
| MP 032 | RF shield insulator, upper | 574-3500-067 |
| MP 033 | Battery block comp spacer | 574-3500-083 |
| MP 034 | Logic shield gasket non-UCM | 574-3500-085 |
| | Logic shield insulator, UCM only | 574-3500-068 |
| MP 035 | Gasket, rear housing | 032-0431-177 |
| MP 040 | Switch holder | 032-0431-171 |
| MP 101 | Bezel, limited keypad models | 032-0431-156 |
| | Bezel, DTMF keypad models | 032-0431-154 |
| MP 104 | Emergency button | 032-0431-165 |
| MP 105 | Selector ring, 3-position switch | 015-0805-653 |
| MP 106 | Spacer, 3-position switch | 032-0431-166 |
| MP 107 | Knob, select sw with D-clip hi ret | 032-0431-183 |
| MP 108 | Knob, volume with D-clip hi ret | 032-0431-185 |
| MP 109 | Water barrier, microphone | 574-3500-053 |
| MP 110 | Keypad, rubber for limited version | 032-0431-175 |
| | Keypad, rubber for DTMF ver. | 032-0431-173 |
| MP 111 | Water barrier/foam ring, speaker | 574-3500-056 |
| MP 112 | Foam ring, speaker | See MP111 |
| MP 113 | Speaker retention ring | 017-2229-557 |
| MP 114 | Front lens attachment | 574-3500-057 |
| MP 115 | LCD lens | 032-0431-157 |
| MP 116 | Foam frame, lens | 574-3500-059 |
| MP 120 | Acsry jack (UDC) dust cover | 032-0431-181 |
| MP 401 | Foam frame, display backlight | 574-3500-065 |
| MP 402 | Optic locator, .37" x .37" x .03 thk | 574-3500-087 |
| NP 003 | Label, RF exposure caution | 559-5000-556 |
| NP 101 | Label, EFJ logo front | 559-5000-550 |
| NP 102 | Label, bottom for thru hole | 559-5000-552 |
| PC 010 | Flex circuit, access (UDC) conn. | 035-5100-010 4 |
| PC 040 | Flex circuit, top switch rev 4 | 035-5100-040 4 |
| R 101 | Volume/on-off switch revised | 562-0018-067 |
| S 101 | Select switch, 16-pos/3-pos | 583-2009-045 |
| SP 101 | Speaker, 45 mm 16-ohm | 589-1015-008 |
| RF BOARD (A200) | | |
| Individual replacement parts are not available. Replace entire assembly. See A200. | | |

LOGIC BOARD (VERSION C)

| Ref No. | Description | Part No. |
|--------------------------------------------------------|---------------------------------------|--------------|
| LOGIC BOARD (A100) | | |
| Part No. 023-5500-120 (Version C, see Section 1.13) | | |
| C 001 | 10 pF $\pm 10\%$ 25V cer smd | 510-3681-100 |
| C 002 | 10 pF $\pm 10\%$ 25V cer smd | 510-3681-100 |
| C 014 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 015 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 016 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 017 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 018 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 019 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 020 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 021 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 022 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 023 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 024 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 025 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 026 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 027 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 030 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 031 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 032 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 033 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 034 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 035 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 058 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 059 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 063 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 064 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 065 | 4.7 μ F 10V tantalum | 510-2624-479 |
| C 066 | 10 μ F 10V cer smd | 510-3755-106 |
| C 067 | 22 μ F $\pm 10\%$ X5R 16V cer smd | 510-3607-226 |
| C 069 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 070 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 071 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 072 | 150 μ F 6V tantalum smd | 510-2001-151 |
| C 073 | 150 μ F 6V tantalum smd | 510-2001-151 |
| C 076 | 4.7 μ F 10V tantalum | 510-2624-479 |
| C 077 | 10 μ F 10V cer smd | 510-3755-106 |
| C 078 | 4.7 μ F 10V tantalum | 510-2624-479 |
| C 079 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 080 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 081 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 082 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |

LOGIC BOARD (VERSION C)

| Ref No. | Description | Part No. |
|---------|-------------------------------------------|--------------|
| C 083 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 084 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 085 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 086 | 470 pF $\pm 10\%$ 25V cer smd | 510-3681-471 |
| C 087 | 33 pF $\pm 10\%$ 25V cer smd | 510-3681-330 |
| C 088 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 089 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 090 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 091 | 22 μ F $\pm 10\%$ X5R 16V cer smd | 510-3607-226 |
| C 092 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 100 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 101 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 102 | 4.7 μ F 10V tantalum | 510-2624-479 |
| C 103 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 104 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 105 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 106 | 4.7 μ F 10V tantalum | 510-2624-479 |
| C 108 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 109 | 22 μ F $\pm 10\%$ X5R 16V cer smd | 510-3607-226 |
| C 110 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 111 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 114 | 10 pF $\pm 10\%$ 25V cer smd | 510-3681-100 |
| C 115 | 10 pF $\pm 10\%$ 25V cer smd | 510-3681-100 |
| C 117 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 118 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 119 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 120 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 121 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 122 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 123 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 124 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 125 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 126 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 127 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 128 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 129 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 130 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 131 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 132 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 133 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 134 | .1 μ F $\pm 80/-20\%$ X7R 25V cer smd | 510-3682-104 |
| C 135 | 10 μ F 15V tantalum smd | 510-2605-100 |
| CR 001 | Dual diode, common anode | 523-1504-024 |
| CR 002 | 3.6V zener diode | 523-2016-369 |

| Ref No. | Description | Part No. |
|---------|-------------------------------|----------------|
| CR 004 | Switching diode | 523-1004-021 |
| CR 006 | 3.6V zener diode | 523-2016-369 |
| CR 007 | 3.6V zener diode | 523-2016-369 |
| J 001 | Connector, 26-pin ZIF 0.5mm | 515-7111-526 |
| J 002 | Connector, 60-pin bd to bd | 515-7111-650 |
| J 003 | Spring clip | 537-5001-014 |
| J 004 | Spring clip | 537-5001-014 |
| L 003 | 10 μ H smd inductor | 542-9009-100 |
| L 004 | 10 μ H smd inductor | 542-9009-100 |
| L 005 | 270 nH smd inductor | 542-9017-274 |
| L 007 | 270 nH smd inductor | 542-9017-274 |
| L 010 | 270 nH smd inductor | 542-9017-274 |
| L 011 | 27 μ H 1.2A smd inductor | 542-5010-019 |
| L 013 | 270 nH smd inductor | 542-9017-274 |
| L 014 | 270 nH smd inductor | 542-9017-274 |
| L 015 | 270 nH smd inductor | 542-9017-274 |
| L 016 | 10 μ H smd inductor | 542-9009-100 |
| PC 001 | PC board, 5500 logic rev 1 | 035-5500-120 1 |
| Q 001 | Power MOSFET N+P pair 20 volt | 576-0006-244 |
| Q 002 | General purpose 3904 | 576-0001-029 |
| Q 003 | Power MOSFET N+P pair 20 volt | 576-0006-244 |
| R 001 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 002 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 003 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 004 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 005 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 006 | 0 ohm jumper | 569-0165-001 |
| R 007 | 0 ohm jumper | 569-0165-001 |
| R 008 | 0 ohm jumper | 569-0165-001 |
| R 009 | 0 ohm jumper | 569-0165-001 |
| R 010 | 0 ohm jumper | 569-0165-001 |
| R 019 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 020 | 15k ohm $\pm 5\%$ 1/16W smd | 569-0155-153 |
| R 022 | 20k ohm $\pm 5\%$ 1/16W smd | 569-0165-203 |
| R 023 | 15k ohm $\pm 5\%$ 1/16W smd | 569-0155-153 |
| R 024 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 025 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 026 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 027 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 028 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |

LOGIC BOARD (VERSION C)

| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 029 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 030 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 031 | 30k ohm $\pm 5\%$ 1/16W smd | 569-0165-303 |
| R 032 | 30k ohm $\pm 5\%$ 1/16W smd | 569-0165-303 |
| R 033 | 20k ohm $\pm 5\%$ 1/16W smd | 569-0165-203 |
| R 034 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 040 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 041 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 042 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 043 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 044 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 045 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 046 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 047 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 048 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 049 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 050 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 051 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 052 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 053 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 054 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 055 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 057 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 059 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 060 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 061 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 062 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 063 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 064 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 065 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 067 | 0 ohm jumper | 569-0165-001 |
| R 068 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 069 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 071 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 074 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 075 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 077 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 078 | 221k ohm $\pm 1\%$ 1/16W smd | 569-0161-534 |
| R 081 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0151-501 |
| R 088 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 090 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 091 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 092 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |

| Ref No. | Description | Part No. |
|---------|-----------------------------|--------------|
| R 096 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 097 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 098 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 100 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 101 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 102 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 104 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 105 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 106 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 107 | 20k ohm $\pm 5\%$ 1/16W smd | 569-0155-203 |
| R 108 | 13k ohm $\pm 5\%$ 1/16W smd | 569-0155-133 |
| R 110 | 39k ohm $\pm 5\%$ 1/16W smd | 569-0155-393 |
| R 111 | 12k ohm $\pm 5\%$ 1/16W smd | 569-0155-123 |
| R 180 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 182 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 186 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 188 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 189 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 190 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 191 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 192 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 193 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 194 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 195 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 224 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 236 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 237 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 238 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 239 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 240 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 241 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 242 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 243 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 244 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 245 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 246 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 247 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 248 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 249 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 251 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 253 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 254 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 255 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |

LOGIC BOARD (VERSION C)

| Ref No. | Description | Part No. |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------|
| R 256 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 257 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 258 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 259 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 260 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 261 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 262 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 263 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| U 008 | Op amp, quad OPA4340 | 544-2020-013 |
| U 009 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 011 | Regulator, 5V 400 mA REG113EA | 544-2603-055 |
| U 013 | Regulator, 3.8V, 50 mA LP2982 | 544-5001-335 |
| U 015 | DSP TMS3205510AGGWA1 | 544-5003-133 |
| U 016 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 017 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 018 | Regulator, 5V 400 mA REG113EA | 544-2603-055 |
| U 019 | Schmitt trig, inv TC7S14F-TE85L | 544-3123-014 |
| U 020 | Programmable logic | 544-5001-420 |
| U 021 | D flip-flop, single NC7SP74 | 544-1010-045 |
| U 022 | SEM encryption module | 023-5000-980 |
| U 026 | Op amp, quad OPA2340 | 544-2018-015 |
| U 027 | CODEC 16-bit TLV320AIC21 | 544-3016-057 |
| U 042 | Regulator, adj 500mA REG103UA | 544-2603-057 |
| U 043 | Regulator, adj 500mA REG103UA | 544-2603-057 |
| U 045 | Regulator, 3.3V 400m REG113EA | 544-2603-056 |
| U 046 | Converter, step down TPS62054 | 544-4006-012 |
| U 047 | Converter, step down TPS62056 | 544-4006-014 |
| U 049 | Converter, step down TPS62050 | 544-4006-010 |
| Y 001 | Oscillator, 20.000 MHz SMD | 561-9004-200 |
| Y 002 | TCXO 12.288 MHz | 518-7012-200 |
| LOGIC BOARD (A100) Part No. 023-5100-110 (early w/o module) Part No. 023-5100-150 (for EFJ SEM) Part No. 023-5100-160 (for Mot UCM) (Version A and B, see Section 1.13) | | |
| A 022 | SEM encryption module (-150 EFJ SEM bd only) UCM encrpt module NNTN4433A (-160 UCM bd only) | 023-5000-980 585-5000-924 |
| C 001 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 002 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |

LOGIC BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|-------------------------------------------------------------------------------------------------------------------------|------------------------------|
| C 003 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 004 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 005 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 006 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 007 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 008 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 009 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 010 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 011 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 012 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 013 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 014 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 015 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 016 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 017 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 018 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 019 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 020 | .22 μF 16V cer smd (All except -160 bd) .01 μF $\pm 10\%$ X7R 25V cer smd (-160 bd only) | 510-3680-224 510-3675-103 |
| C 021 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 022 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 023 | 470 pF $\pm 10\%$ 25V cer smd | 510-3681-471 |
| C 024 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 025 | 5.1 pF ± 1 pF NPO cer smd | 510-3673-519 |
| C 026 | 6.2 pF ± 1 pF NPO cer smd | 510-3673-629 |
| C 027 | 10 pF ± 1 pF NPO cer smd | 510-3673-100 |
| C 028 | 470 pF $\pm 10\%$ 25V cer smd | 510-3681-471 |
| C 029 | 5.6 pF $\pm 10\%$ 25V cer smd | 510-3681-569 |
| C 030 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 031 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 032 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 033 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 034 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 035 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 036 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 037 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 038 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 039 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 040 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 041 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 042 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 043 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 044 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |

LOGIC BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|--------------------------------------|--------------|
| C 045 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 046 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 047 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 048 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 049 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 050 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 051 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 052 | 8.2pF \pm 10% NPO cer smd | 510-3673-829 |
| C 054 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 055 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 056 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 058 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 059 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 060 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 063 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 064 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 065 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 066 | 10 μ F 10V cer smd | 510-3755-106 |
| C 067 | 10 μ F 10V cer smd | 510-3755-106 |
| C 068 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 069 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 070 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 071 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 072 | 150 μ F 6V tantalum smd | 510-2001-151 |
| C 073 | 150 μ F 6V tantalum smd | 510-2001-151 |
| C 077 | 10 μ F 10V cer smd | 510-3755-106 |
| C 078 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 079 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 080 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 081 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 082 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 083 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 084 | 33 pF \pm 10% 25V cer smd | 510-3681-330 |
| C 085 | 33 pF \pm 10% 25V cer smd | 510-3681-330 |
| C 086 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 087 | 470 pF \pm 10% 25V cer smd | 510-3681-471 |
| C 088 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 089 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 091 | 10 μ F 10V cer smd | 510-3755-106 |
| C 099 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 100 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 101 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 102 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 104 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 105 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 106 | 10 pF \pm 10% NPO cer smd | 510-3673-100 |

| Ref No. | Description | Part No. |
|---------|----------------------------------------------------|----------------|
| C 107 | 10 pF \pm 10% NPO cer smd | 510-3673-100 |
| CR 001 | Dual diode, common anode | 523-1504-024 |
| CR 002 | 3.6V zener diode | 523-2016-369 |
| CR 004 | Switching diode | 523-1004-021 |
| CR 005 | 5.6V zener diode | 523-2016-569 |
| CR 006 | 3.6V zener diode | 523-2016-369 |
| D 001 | PIN diode | 523-1504-001 |
| J 001 | Connector, 20-pin ZIF .5 mm | 515-7111-520 |
| J 002 | Connector, 60-pin bd to bd (all except -160 bd) | 515-7111-650 |
| | Connector, 60-pin bd to bd (-160 bd only) | 515-7111-652 |
| J 003 | Spring clip | 537-5001-014 |
| J 004 | Spring clip | 537-5001-014 |
| J 016 | Socket, 25-pin (-160 bd only) | 515-7113-071 |
| L 001 | 1.8 μ H smd inductor | 542-9017-189 |
| L 003 | 10 μ H smd power inductor | 542-9009-100 |
| L 004 | 10 μ H smd power inductor | 542-9009-100 |
| L 005 | 270 nH smd inductor | 542-9017-274 |
| L 006 | 270 nH smd inductor | 542-9017-274 |
| L 007 | 270 nH smd inductor | 542-9017-274 |
| L 008 | 270 nH smd inductor | 542-9017-274 |
| L 009 | 270 nH smd inductor | 542-9017-274 |
| L 010 | 270 nH smd inductor | 542-9017-274 |
| L 011 | Ferrite bead | 517-2503-002 |
| PC 001 | PC board, -110 rev 7 | 035-5100-100 7 |
| | PC board, -150 EFJ SEM rev 1 | 035-5100-150 1 |
| | PC board, -160 Mot UCM rev 4 | 035-5100-160 4 |
| Q 001 | Power MOSFET N+P pair 20 volt | 576-0006-244 |
| Q 002 | General purpose 3904 | 576-0001-029 |
| Q 003 | Power MOSFET N+P pair 20 volt | 576-0006-244 |
| Q 004 | NPN general purpose | 576-0003-616 |
| R 001 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 002 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 003 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 004 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 005 | 100 ohm \pm 5% 1/16W smd | 569-0165-101 |
| R 006 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 007 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |

LOGIC BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 008 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 009 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 010 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 011 | 6.8k ohm $\pm 5\%$ 1/16W smd | 569-0165-682 |
| R 012 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 013 | 390k ohm $\pm 5\%$ 1/16W smd | 569-0165-394 |
| R 014 | 0 ohm smd jumper | 569-0165-001 |
| R 015 | 1M ohm $\pm 5\%$ 1/16W smd | 569-0165-105 |
| R 016 | 15k ohm $\pm 5\%$ 1/16W smd | 569-0165-153 |
| R 017 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| | (all except -160 bd) | |
| | 10k ohm $\pm 5\%$ 1/16W smd | 569-0155-103 |
| | (-160 bd only) | |
| R 018 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 019 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| | (all except -160 bd) | |
| | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| | (-160 bd only) | |
| R 020 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 021 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 022 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 023 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| | (all except -160 bd) | |
| | 10k ohm $\pm 5\%$ 1/16W smd | 569-0155-103 |
| | (-160 bd only) | |
| R 024 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 025 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 026 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 027 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 028 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 029 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 030 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 031 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 032 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 033 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 034 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 035 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 036 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 037 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 038 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 039 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 040 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 041 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 042 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 043 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |

| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 044 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 045 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 046 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 047 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 048 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 049 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 050 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 051 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 052 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 053 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 054 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 055 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 056 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 057 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 058 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 059 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 060 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 061 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 062 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 063 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 064 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 065 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 067 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0155-103 |
| R 068 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 069 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 070 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 071 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 072 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 074 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 075 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 077 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 078 | 232k ohm $\pm 1\%$ 1/16W smd | 569-0151-536 |
| | (-110 board) | |
| | 255k ohm $\pm 1\%$ 1/16W smd | 569-0151-551 |
| | (-150 EFJ SEM board) | |
| R 079 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0151-501 |
| R 088 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 089 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 090 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 091 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 092 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 093 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 094 | 634k ohm $\pm 1\%$ 1/16W smd | 569-0151-578 |
| R 095 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0151-501 |
| R 096 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0155-103 |

LOGIC BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|-----------------------------------|--------------|
| R 097 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 098 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 099 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| U 001 | DSP TI TMS320VC5416 | 544-5003-129 |
| U 002 | ADSIC | 544-9100-002 |
| U 003 | 16-bit transceiver 74LVTH16245 | 544-1014-505 |
| U 004 | Transceiver, 3-state 74ACT16245 | 544-2023-071 |
| U 005 | 3-state buffer, quad 74ACT125 | 544-3776-117 |
| U 006 | 3-state buffer 74ACT16244 | 544-3776-119 |
| U 007 | Programmable logic | 544-1015-066 |
| U 008 | Op amp, quad OPA4340 | 544-2020-013 |
| U 009 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 010 | Op amp, dual OPA2340 | 544-2018-015 |
| U 011 | Regulator, 5V 400 mA REG113EA | 544-2603-055 |
| U 012 | DC-DC converter TPS6200 | 544-4006-011 |
| U 013 | Regulator, 3.8V, 50 mA LP2982 | 544-5001-335 |
| U 014 | DC-DC converter TPS6200 | 544-4006-011 |
| U 016 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 017 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 018 | Regulator, 5V 400 mA REG113EA | 544-2603-055 |
| U 019 | Bus xcvr, octal 74LVCC3245 | 544-1010-250 |
| U 020 | Bus xcvr, octal 74LVCC3245 | 544-1010-250 |
| U 021 | Tri state buffer, 3.3V NC7SZ125P5 | 544-3914-125 |
| U 022 | 3-state buffer, quad 74ACT125 | 544-3776-117 |
| U 023 | Reg, dual 3.3/1.5V TPS70148 | 544-2003-177 |
| U 024 | Prog logic array CPLD 3064 | 544-5001-419 |
| U 025 | Schmitt trig, inv TC7S14F-TE85L | 544-3123-014 |
| U 027 | Regulator, 5V 400 mA REG113EA | 544-2603-055 |
| Y 001 | 20.000 MHz crystal | 521-0020-001 |

USER INTERFACE BOARD (A400)

Part No. 023-5500-420
(Version C, see Section 1.13)

| | | |
|-------|---------------------------------------------|--------------|
| C 001 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 002 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 003 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 004 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 005 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 006 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 007 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 008 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 009 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 010 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |

USER INTERFACE BOARD (VERSION C)

| | | |
|-------|-----------------------------------------------|--------------|
| C 011 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 012 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 013 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 014 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 015 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 016 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 017 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 018 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 019 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 020 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 021 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 022 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 023 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 024 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 025 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 026 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 027 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 028 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 029 | 10 μF 10V cer smd | 510-3755-106 |
| C 030 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 031 | 3300 pF $\pm 10\%$ 10V cer smd | 510-3681-332 |
| C 032 | 56 pF 50V cer smd | 510-3684-560 |
| C 033 | 47 pF $\pm 10\%$ 10V cer smd | 510-3681-470 |
| C 034 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 035 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 036 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 037 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 038 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 042 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 043 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 044 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 045 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 046 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 047 | 680 pF $\pm 10\%$ X7R 25V cer smd | 510-3675-681 |
| C 048 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 049 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 050 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 051 | .001 μF $\pm 10\%$ XRF 10V cer smd | 510-9227-102 |
| C 052 | .01 μF $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 053 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 054 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 055 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 056 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 057 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 058 | .1 μF $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |

USER INTERFACE BOARD (VERSION C)

| Ref No. | Description | Part No. |
|---------|------------------------------------------|--------------|
| C 059 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 060 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 061 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 062 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 063 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 064 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 065 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 066 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 067 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 068 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 069 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 070 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 071 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 072 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 073 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 074 | 68 pF \pm 5% NPO cer smd | 510-3674-680 |
| C 075 | 68 pF \pm 5% NPO cer smd | 510-3674-680 |
| C 076 | 4.7 μ F 10V tantalum | 510-2604-479 |
| C 077 | 4.7 μ F 10V tantalum | 510-2604-479 |
| C 078 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 079 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 080 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 081 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 082 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 083 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 084 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 085 | 680 pF \pm 10% X7R 25V cer smd | 510-3675-681 |
| C 086 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 087 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 088 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 089 | 220 pF \pm 10% NPO 25V cer smd | 510-3674-221 |
| C 090 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 091 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 092 | .1 μ F \pm 80/-20% X7R 25V cer smd | 510-3682-104 |
| C 093 | .1 μ F \pm 80/-20% X7R 25V cer smd | 510-3682-104 |
| C 094 | .1 μ F \pm 80/-20% X7R 25V cer smd | 510-3682-104 |
| C 095 | .1 μ F \pm 80/-20% X7R 25V cer smd | 510-3682-104 |
| C 096 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 097 | .1 μ F \pm 80/-20% X7R 25V cer smd | 510-3682-104 |
| C 098 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 099 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 101 | 270 pF \pm 5% NPO cer smd | 510-3674-271 |
| C 102 | .001 μ F \pm 10% 25V cer smd | 510-3681-102 |
| C 103 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 104 | 1.0 μ F 16V cer smd | 510-3923-105 |

| Ref No. | Description | Part No. |
|---------|--------------------------------------|--------------|
| C 105 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 106 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 107 | 1.0 μ F 16V cer smd | 510-3923-105 |
| C 108 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 109 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 110 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 111 | 2.2 μ F 16V cer smd | 510-3925-225 |
| C 112 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 113 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 114 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 115 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 116 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 119 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 120 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 121 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 131 | .001 μ F \pm 10% 10V cer smd | 510-9227-102 |
| C 132 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 133 | 470 pF \pm 5% NPO 25V cer smd | 510-3674-471 |
| C 134 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 135 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 136 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 137 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 138 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 139 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 140 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 141 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 142 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 143 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 144 | 100 pF \pm 10% 25V cer smd | 510-3681-101 |
| C 155 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 156 | .001 μ F \pm 10% 25V cer smd | 510-3681-102 |
| CR 003 | 5.6V zener diode | 523-2016-569 |
| CR 004 | 5.6V zener diode | 523-2016-569 |
| CR 006 | 5.6V zener diode | 523-2016-569 |
| CR 007 | 5.6V zener diode | 523-2016-569 |
| CR 008 | LED, dual color red/green | 549-4001-215 |
| CR 033 | Dual diode, common cathode | 523-1504-024 |
| CR 035 | LED, green high intensity | 549-4001-029 |
| CR 037 | LED, green RG1101 smd | 549-4003-011 |
| CR 038 | LED, green RG1101 smd | 549-4003-011 |
| CR 039 | LED, green RG1101 smd | 549-4003-011 |
| CR 040 | LED, green RG1101 smd | 549-4003-011 |
| CR 041 | LED, green RG1101 smd | 549-4003-011 |
| CR 042 | LED, green RG1101 smd | 549-4003-011 |

USER INTERFACE BOARD (VERSION C)

| Ref No. | Description | Part No. |
|---------|------------------------------------|--------------|
| CR 043 | LED, green RG1101 smd | 549-4003-011 |
| CR 044 | 5.6V zener diode | 523-2016-569 |
| DS 401 | See DS401 on page 7-1 | |
| J 001 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 002 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 003 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 004 | Connector, 18-pin ZIF 1 mm | 515-7111-518 |
| J 005 | Connector, 60-pin bd to bd | 515-7111-651 |
| J 006 | Ground clip | 537-5001-015 |
| J 008 | Spring clip | 537-5001-014 |
| J 009 | Spring clip | 537-5001-014 |
| L 001 | 8.2 μ H \pm 5% chip inductor | 542-9000-829 |
| L 003 | .1 μ H smd inductor | 542-9017-108 |
| L 004 | .1 μ H smd inductor | 542-9017-108 |
| PC 001 | PC board, user interface rev 0 | 035-5500-420 |
| Q 001 | General purpose 3904 | 576-0001-029 |
| Q 002 | General purpose 3904 | 576-0001-029 |
| Q 003 | General purpose 3904 | 576-0001-029 |
| Q 004 | General purpose 3904 | 576-0001-029 |
| Q 005 | General purpose 3904 | 576-0001-029 |
| Q 006 | General purpose 3904 | 576-0001-029 |
| Q 007 | General purpose 3904 | 576-0001-029 |
| Q 008 | General purpose 3904 | 576-0001-029 |
| Q 009 | General purpose 3904 | 576-0001-029 |
| Q 010 | General purpose 3904 | 576-0001-029 |
| Q 012 | General purpose 3904 | 576-0001-029 |
| Q 013 | General purpose 3904 | 576-0001-029 |
| R 001 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 002 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 003 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 004 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 005 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 006 | 1k ohm \pm 5% 1/16W smd | 569-0165-102 |
| R 007 | 10M ohm \pm 5% 1/16W smd | 569-0165-106 |
| R 008 | 0 ohm jumper | 569-0165-001 |
| R 009 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 010 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 011 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 013 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |

| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 014 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 015 | 20k ohm \pm 1% 1/16W smd | 569-0161-432 |
| R 016 | 825k ohm \pm 1% 1/16W smd | 569-0161-589 |
| R 017 | 10k ohm \pm 1% 1/16W smd | 569-0161-401 |
| R 018 | 6.81k ohm \pm 1% 1/16W smd | 569-0161-381 |
| R 019 | 100k ohm \pm 1% 1/16W smd | 569-0161-501 |
| R 020 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 021 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 022 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 023 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 024 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 025 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 026 | 1k ohm \pm 5% 1/16W smd | 569-0165-102 |
| R 027 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 028 | 2k ohm \pm 5% 1/16W smd | 569-0165-202 |
| R 029 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 030 | 2k ohm \pm 5% 1/16W smd | 569-0165-202 |
| R 031 | 2k ohm \pm 5% 1/16W smd | 569-0165-202 |
| R 032 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 033 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 034 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 035 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 037 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 038 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 039 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 040 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 041 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 044 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 045 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 046 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 047 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 048 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 049 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 050 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 051 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 052 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 054 | 619 ohm \pm 1% 1/16W smd | 569-0151-277 |
| R 055 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 056 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 057 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 058 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 059 | 82 ohm \pm 5% 1/16W smd | 569-0105-820 |
| R 060 | 1k ohm \pm 5% 1/16W smd | 569-0165-102 |
| R 061 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 063 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |

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| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 064 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 065 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 066 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 067 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 068 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 069 | 1M ohm $\pm 5\%$ 1/16W smd | 569-0165-105 |
| R 070 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 071 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 072 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 073 | 33k ohm $\pm 5\%$ 1/16W smd | 569-0165-333 |
| R 074 | 0 ohm jumper | 569-0165-001 |
| R 075 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 076 | 2.2k ohm $\pm 5\%$ 1/16W smd | 569-0165-222 |
| R 077 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 078 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 079 | 75k ohm $\pm 5\%$ 1/16W smd | 569-0165-753 |
| R 080 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 081 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 082 | 51k ohm $\pm 5\%$ 1/16W smd | 569-0165-513 |
| R 083 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 084 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 085 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 086 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 087 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 088 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 089 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 090 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 091 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 092 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 093 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 094 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 095 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 096 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 097 | 75 ohm $\pm 5\%$ 1/16W smd | 569-0155-750 |
| R 098 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 099 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 100 | 15k ohm $\pm 5\%$ 1/16W smd | 569-0165-153 |
| R 101 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 102 | 18k ohm $\pm 5\%$ 1/16W smd | 569-0165-183 |
| R 103 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 104 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 105 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 106 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 107 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 108 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |

| Ref No. | Description | Part No. |
|---------|-------------------------------|--------------|
| R 110 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 111 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 112 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 113 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 114 | 2.2k ohm $\pm 5\%$ 1/16W smd | 569-0165-222 |
| R 115 | 49.9k ohm $\pm 1\%$ 1/16W smd | 569-0161-468 |
| R 116 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 117 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 118 | 100k ohm $\pm 1\%$ 1/16W smd | 569-0161-501 |
| R 119 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 120 | 49.9k ohm $\pm 1\%$ 1/16W smd | 569-0161-468 |
| R 122 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 123 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 128 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 129 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 130 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 131 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 132 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 135 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 136 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 137 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 138 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 139 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 140 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 141 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 142 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 143 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 144 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 145 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 146 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 147 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 148 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 149 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 150 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 151 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 152 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 153 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 154 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 155 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 156 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 157 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 158 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 159 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 160 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 161 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |

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| Ref No. | Description | Part No. |
|---------|--------------------------------|--------------|
| R 162 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 163 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 164 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 165 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 166 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 167 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 168 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 169 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 170 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 171 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 172 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 173 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 176 | 75 ohm $\pm 5\%$ 1/16W smd | 569-0155-750 |
| R 180 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 238 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 239 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 244 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 245 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 246 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 247 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 248 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 249 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 250 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 252 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 254 | 47k ohm $\pm 5\%$ 1/16W smd | 569-0165-473 |
| R 255 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 256 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 262 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 263 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 269 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 270 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 271 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 272 | 0 ohm smd jumper | 569-0165-001 |
| R 273 | 0 ohm smd jumper | 569-0165-001 |
| R 274 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 275 | 10 ohm $\pm 5\%$ 1/16W smd | 569-0165-100 |
| R 276 | 8.2k ohm $\pm 5\%$ 1/16W smd | 569-0165-822 |
| U 001 | Microcontroller PowerPC MPC850 | 544-5003-127 |
| U 003 | A/D converter, 10 bit LTC1199 | 544-2031-005 |
| U 004 | Flash 8M x 8 AM29DL640G90 | 544-5001-255 |
| U 005 | Prog logic XC2C64-7CP561 | 544-5001-420 |
| U 006 | SRAM 1M x 16 CY62167DV30L | 544-1028-198 |
| U 007 | D/A converter, 8-bit TLV5623 | 544-2031-016 |
| U 008 | Audio amp, 750 mW LM4865 | 544-2006-028 |

USER INTERFACE BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------------|
| U 009 | A/D converter, 10 bit LTC1199 | 544-2031-005 |
| U 010 | Op amp, quad OPA340 | 544-2020-023 |
| U 011 | Buffer, quad 74LCX125 | 544-3776-127 |
| U 012 | Programmable logic | 544-5001-418 |
| U 013 | AND gate, 2-input TC7S08FU | 544-3766-020 |
| U 014 | Op amp, quad OPA340 | 544-2020-023 |
| U 016 | EEPROM 32k x 8 M24256 | 544-1019-376 |
| U 017 | Op amp, quad OPA4340 | 544-2020-013 |
| U 018 | Op amp, quad OPA340 | 544-2020-023 |
| U 019 | Op amp, quad OPA4340 | 544-2020-013 |
| U 020 | Op amp, quad OPA340 | 544-2020-023 |
| U 021 | Audio amp, 750 mW LM4865 | 544-2006-028 |
| U 022 | Buffer, 3-state 3.3V | 544-3914-125 |
| U 024 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 026 | Triple supply monitor LT1727 | 544-5001-341 |
| U 033 | Buffer, 3-state 3.3V | 544-3914-125 |
| U 034 | Diff comparator, dual TLC3521D | 544-2025-021 |
| U 036 | RS-232 bus xcvr MAX3221EAE | 544-2023-036 |
| Y 001 | Crystal, 4.9152 MHz | 521-3060-022 |
| Y 002 | Osc, 1 kHz to 30 MHz resistor set | 521-9004-701 |
| USER INTERFACE BOARD (A400) Part No. 023-5100-410 (early w/o module) Part No. 023-5100-450 (for EFJ SEM) Part No. 023-5100-460 (for Mot UCM) (Version A and B, see Section 1.13) | | |
| EP 101a | Grounding finger | 537-5001-012 |
| EP 401 | Grounding finger | 537-5001-012 |
| C 001 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 002 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 003 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 004 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 005 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 006 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 007 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 008 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 009 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 010 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 011 | .1 μ F $\pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 012 | .01 μ F $\pm 10\%$ 10V cer smd | 510-3681-103 |
| C 013 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 014 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |

USER INTERFACE BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|---------------------------------------------|--------------|
| C 015 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 016 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 017 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 018 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 019 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 020 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 021 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 022 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 023 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 024 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 025 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 026 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 027 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 028 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 029 | 10 μF 10V cer smd | 510-3755-106 |
| C 030 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 031 | 3300 pF $\pm 10\%$ 10V cer smd | 510-3681-332 |
| C 032 | 56 pF 50V cer smd | 510-3684-560 |
| C 033 | 47 pF $\pm 10\%$ 10V cer smd | 510-3681-470 |
| C 034 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 037 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 038 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 041 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 042 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 043 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 044 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 045 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 046 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 047 | 680 pF $\pm 10\%$ X7R 25V cer smd | 510-3675-681 |
| C 048 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 049 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 050 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 051 | .001 $\mu\text{F} \pm 10\%$ XRF 10V cer smd | 510-9227-102 |
| C 052 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 053 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 054 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 055 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 056 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 057 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 058 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 059 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 060 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 061 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 062 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 063 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |

| Ref No. | Description | Part No. |
|---------|-------------------------------------------|--------------|
| C 064 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 065 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 066 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 067 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 068 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 069 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 072 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 073 | 100 pF $\pm 10\%$ 25V cer smd | 510-3681-101 |
| C 076 | 4.7 μF 10V tantalum | 510-2624-479 |
| C 077 | 4.7 μF 10V tantalum | 510-2624-479 |
| C 078 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 079 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 080 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 081 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 082 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 083 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 084 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 085 | 680 pF $\pm 10\%$ X7R 25V cer smd | 510-3675-681 |
| C 086 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 087 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 088 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 089 | 220 pF $\pm 10\%$ NPO 25V cer smd | 510-3674-221 |
| C 090 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 091 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 096 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 098 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 099 | .1 $\mu\text{F} \pm 10\%$ X7R 25V cer smd | 510-3675-104 |
| C 100 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 101 | 270 pF $\pm 5\%$ NPO cer smd | 510-3674-271 |
| C 103 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 104 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 105 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 106 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 107 | 1.0 μF 16V cer smd | 510-3923-105 |
| C 108 | 2.2 μF 16V cer smd | 510-3925-225 |
| C 109 | 2.2 μF 16V cer smd | 510-3925-225 |
| C 110 | 2.2 μF 16V cer smd | 510-3925-225 |
| C 111 | 2.2 μF 16V cer smd | 510-3925-225 |
| C 112 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 113 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 114 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 115 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 116 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 119 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |
| C 120 | .01 $\mu\text{F} \pm 10\%$ 10V cer smd | 510-3681-103 |

USER INTERFACE BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|-----------------|----------------------------------------------------|--------------|
| C 121 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 131 | .001 μ F \pm 10% 10V cer smd | 510-9227-102 |
| C 132 | .01 μ F \pm 10% 10V cer smd | 510-3681-103 |
| C 133 | 470 pF \pm 5% NPO 25V cer smd | 510-3674-471 |
| C 134 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 135 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 136 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| C 137 | .1 μ F \pm 10% X7R 25V cer smd | 510-3675-104 |
| CR 003 | 5.6V zener diode | 523-2016-569 |
| CR 004 | 5.6V zener diode | 523-2016-569 |
| CR 006 | 5.6V zener diode | 523-2016-569 |
| CR 007 | 5.6V zener diode | 523-2016-569 |
| CR 008 | LED, dual color red/green | 549-4001-215 |
| CR 033 | Dual diode, common cathode | 523-1504-024 |
| CR 037 | LED, green RG1101 smd | 549-4003-011 |
| CR 038 | LED, green RG1101 smd | 549-4003-011 |
| CR 039 | LED, green RG1101 smd | 549-4003-011 |
| CR 040 | LED, green RG1101 smd | 549-4003-011 |
| CR 041 | LED, green RG1101 smd | 549-4003-011 |
| CR 042 | LED, green RG1101 smd | 549-4003-011 |
| CR 043 | LED, green RG1101 smd | 549-4003-011 |
| CR 044 | 5.6V zener diode | 523-2016-569 |
| CR 045 | 5.6V zener diode | 523-2016-569 |
| CR 046 | 5.6V zener diode | 523-2016-569 |
| CR 047 | 5.6V zener diode | 523-2016-569 |
| EP900 | Grounding clip | 537-5001-005 |
| J 001 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 002 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 003 | Connector, 16-pin ZIF .5 mm | 515-7111-516 |
| J 004 | Connector, 18-pin ZIF 1 mm | 515-7111-518 |
| J 005 | Connector, 60-pin bd to bd (all except -160 bd) | 515-7111-651 |
| | Connector, 60-pin bd to bd (-160 bd only) | 515-7111-653 |
| J 008 | Spring clip | 537-5001-014 |
| J 009 | Spring clip | 537-5001-014 |
| L 001 | 8.2 μ H \pm 5% chip inductor | 542-9000-829 |
| L 003 | .1 μ H smd inductor | 542-9017-108 |
| L 004 | .1 μ H smd inductor | 542-9017-108 |
| L 183- L 220 | Ferrite smd inductor | 542-9230-023 |

| Ref No. | Description | Part No. |
|---------|-------------------------------------------------------------|--------------------|
| PC 001 | PC board, user interface rev 10 (-410 bd) | 035-5100-400 10 |
| | PC board, user interface revision 1 (-450 EFJ SEM board) | 035-5100-450 1 |
| | PC board, user interface revision 1 (-460 UCM board) | 035-5100-460 1 |
| Q 001 | General purpose 3904 | 576-0001-029 |
| Q 002 | General purpose 3904 | 576-0001-029 |
| Q 003 | General purpose 3904 | 576-0001-029 |
| Q 004 | General purpose 3904 | 576-0001-029 |
| Q 005 | General purpose 3904 | 576-0001-029 |
| Q 006 | General purpose 3904 | 576-0001-029 |
| Q 007 | General purpose 3904 | 576-0001-029 |
| Q 008 | General purpose 3904 | 576-0001-029 |
| Q 009 | General purpose 3904 | 576-0001-029 |
| Q 010 | General purpose 3904 | 576-0001-029 |
| Q 012 | General purpose 3904 | 576-0001-029 |
| Q 013 | General purpose 3904 | 576-0001-029 |
| R 001 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 002 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 003 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 004 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 005 | 10 ohm \pm 5% 1/16W smd | 569-0165-100 |
| R 006 | 1k ohm \pm 5% 1/16W smd | 569-0165-102 |
| R 007 | 10M ohm \pm 5% 1/16W smd | 569-0165-106 |
| R 009 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 010 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 011 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 013 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 015 | 20k ohm \pm 5% 1/16W smd | 569-0165-203 |
| R 016 | 825k ohm \pm 1% 1/16W smd | 569-0161-589 |
| R 017 | 10k ohm \pm 5% 1/16W smd | 569-0165-103 |
| R 018 | 6.8k ohm \pm 5% 1/16W smd | 569-0165-682 |
| R 019 | 100k ohm \pm 1% 1/16W smd | 569-0161-501 |
| R 020 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 021 | 4.7k ohm \pm 5% 1/16W smd | 569-0165-472 |
| R 022 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 023 | 100k ohm \pm 5% 1/16W smd | 569-0165-104 |
| R 024 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 025 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 026 | 1k ohm \pm 5% 1/16W smd | 569-0165-102 |
| R 027 | 220k ohm \pm 5% 1/16W smd | 569-0165-224 |
| R 028 | 2k ohm \pm 5% 1/16W smd | 569-0165-202 |

USER INTERFACE BOARD (VERSION A/B)

| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 029 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 030 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 031 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 032 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 033 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 034 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 035 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 037 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 038 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 039 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 040 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 041 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 044 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 045 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 046 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 047 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 048 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 049 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 050 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 051 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 052 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 054 | 619 ohm $\pm 1\%$ 1/16W smd | 569-0151-277 |
| R 055 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 057 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 058 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 059 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 060 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 061 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 063 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 064 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 065 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 066 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 067 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 068 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 069 | 1M ohm $\pm 5\%$ 1/16W smd | 569-0165-105 |
| R 070 | 100 ohm $\pm 5\%$ 1/16W smd | 569-0165-101 |
| R 071 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 072 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 073 | 33k ohm $\pm 5\%$ 1/16W smd | 569-0165-333 |
| R 076 | 2.2k ohm $\pm 5\%$ 1/16W smd | 569-0165-222 |
| R 077 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 078 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 079 | 75k ohm $\pm 5\%$ 1/16W smd | 569-0165-753 |
| R 080 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 081 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |

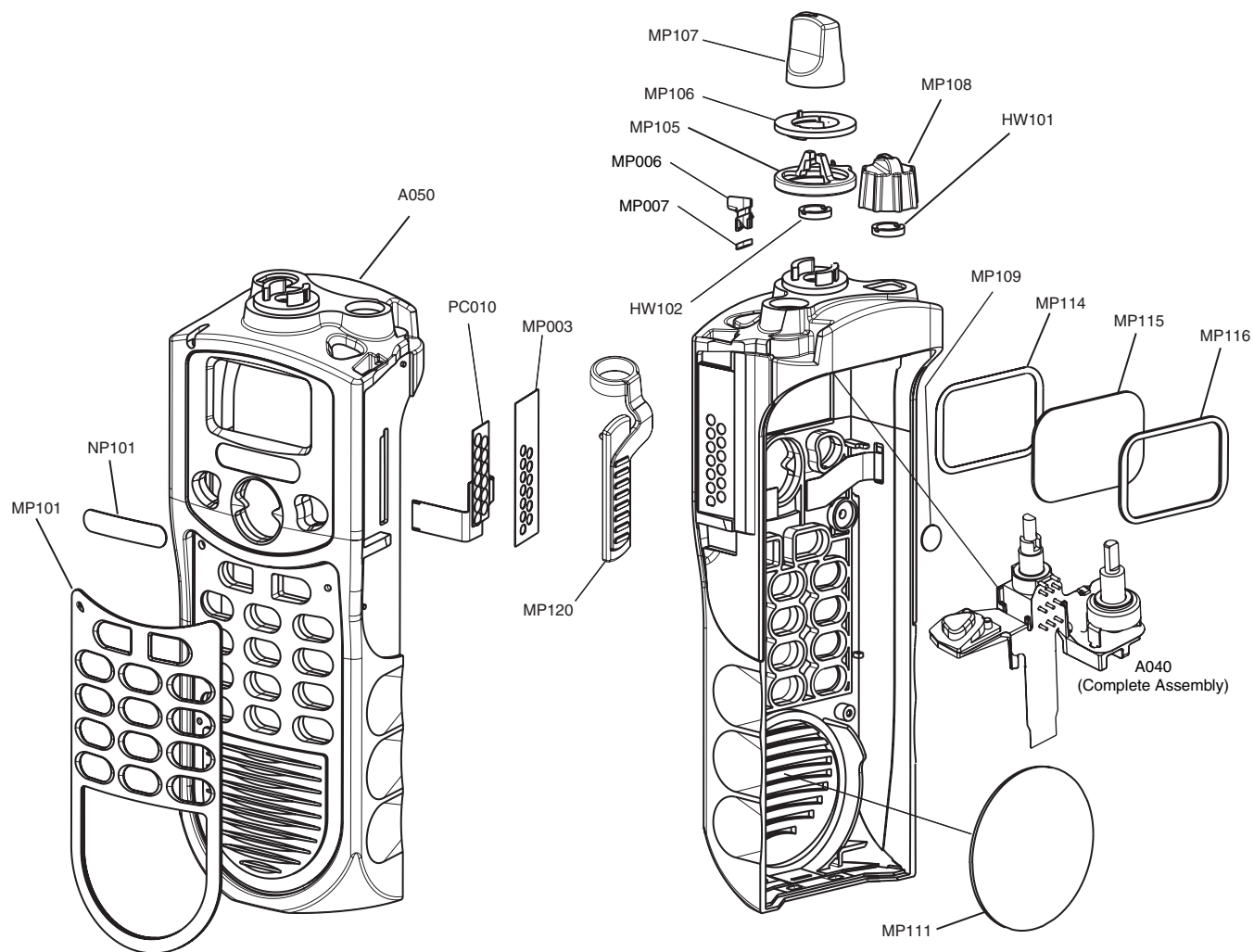
| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 083 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 084 | 47k ohm $\pm 5\%$ 1/16W smd | 569-0165-473 |
| R 085 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 086 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 087 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 088 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 089 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 090 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 091 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 092 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 093 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 094 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 095 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 096 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 097 | 75 ohm $\pm 5\%$ 1/16W smd | 569-0155-750 |
| R 098 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 099 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 101 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 103 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 104 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 105 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 106 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 107 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 110 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 111 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 112 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 113 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 114 | 2.2k ohm $\pm 5\%$ 1/16W smd | 569-0165-222 |
| R 115 | 51k ohm $\pm 5\%$ 1/16W smd | 569-0165-513 |
| R 116 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 117 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 118 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 119 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 120 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 122 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 123 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 126 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 127 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 128 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 129 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 130 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 131 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 132 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 135 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 136 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |

USER INTERFACE BOARD (VERSION A/B)

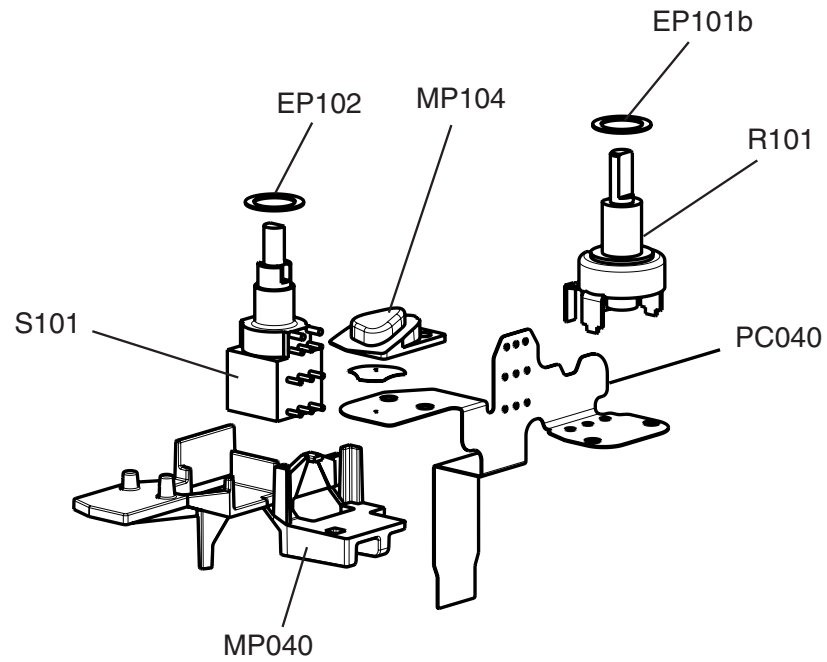
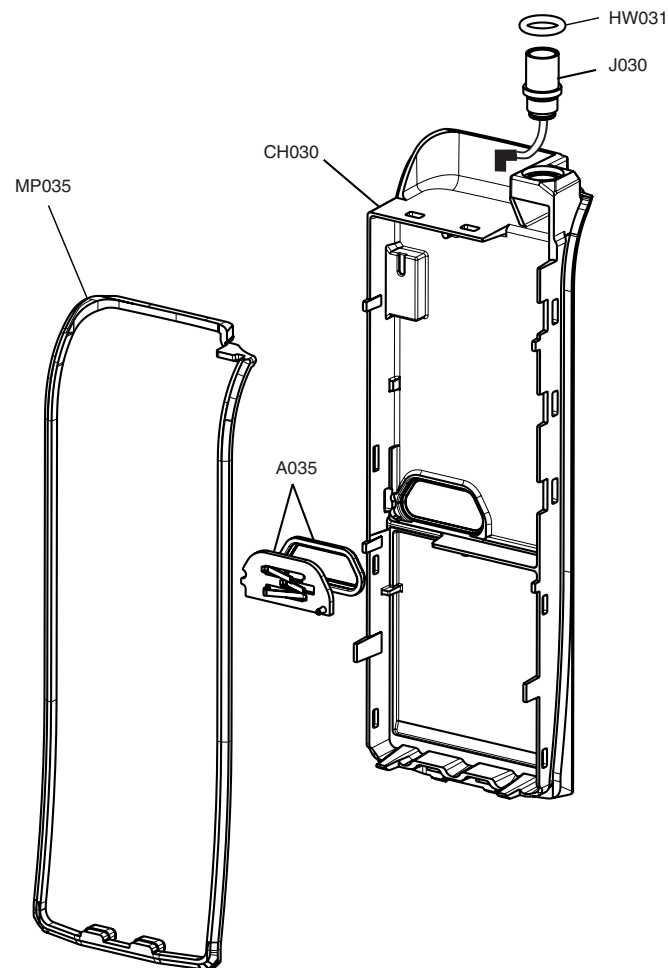
| Ref No. | Description | Part No. |
|---------|------------------------------|--------------|
| R 137 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 138 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 139 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 140 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 141 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 142 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 143 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 144 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 145 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 146 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 147 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 148 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 149 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 150 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 151 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 152 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 153 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 154 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 155 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 156 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 157 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 158 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 159 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 160 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 161 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 162 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 163 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 164 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 165 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 166 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 167 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 168 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 169 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 170 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 171 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 172 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 173 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 176 | 75 ohm $\pm 5\%$ 1/16W smd | 569-0155-750 |
| R 180 | 1k ohm $\pm 5\%$ 1/16W smd | 569-0165-102 |
| R 238 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 239 | 2k ohm $\pm 5\%$ 1/16W smd | 569-0165-202 |
| R 244 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 245 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 246 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |

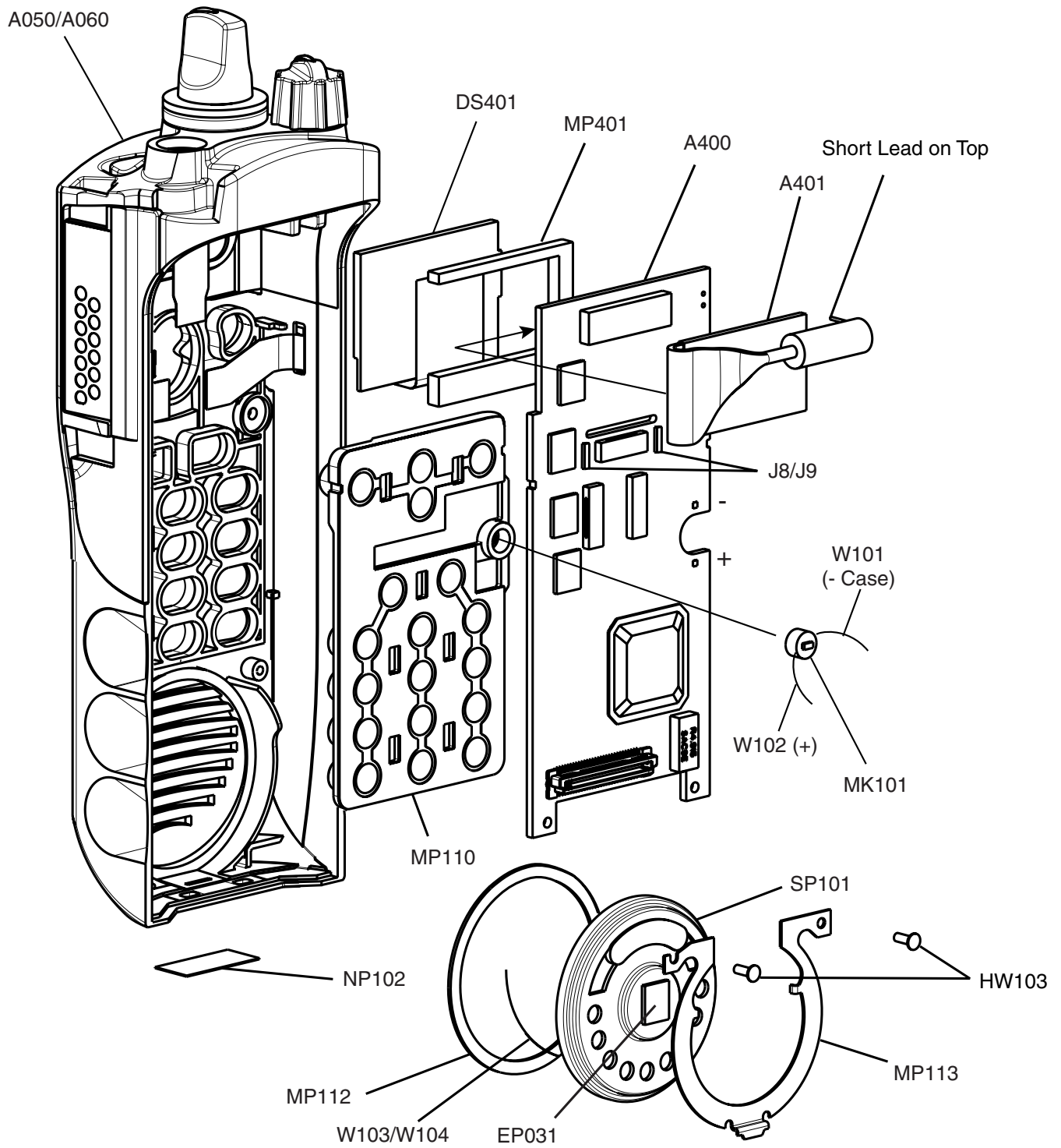
| Ref No. | Description | Part No. |
|---------|-----------------------------------|--------------|
| R 247 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 248 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 249 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 250 | 82 ohm $\pm 5\%$ 1/16W smd | 569-0105-820 |
| R 252 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 254 | 47k ohm $\pm 5\%$ 1/16W smd | 569-0165-473 |
| R 255 | 100k ohm $\pm 5\%$ 1/16W smd | 569-0165-104 |
| R 256 | 4.7k ohm $\pm 5\%$ 1/16W smd | 569-0165-472 |
| R 257 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 258 | 0 ohm jumper | 569-0165-001 |
| R 262 | 220k ohm $\pm 5\%$ 1/16W smd | 569-0165-224 |
| R 263 | 10k ohm $\pm 5\%$ 1/16W smd | 569-0165-103 |
| R 266 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 267 | 470 ohm $\pm 5\%$ 1/16W smd | 569-0165-471 |
| R 268 | 56k ohm $\pm 5\%$ 1/16W smd | 569-0165-563 |
| U 001 | Microcontroller PowerPC MPC850 | 544-5003-127 |
| U 002 | SRAM 256k x 16 CY62146V | 544-5001-213 |
| U 004 | Flash 2M x 16 3.0V | 544-5001-323 |
| U 005 | SRAM 512k x 16 CY62157CV30 | 544-5001-215 |
| U 007 | D/A converter, 8-bit TLV5623 | 544-2031-016 |
| U 008 | Audio amp, 750 mW LM4865 | 544-2006-028 |
| U 009 | A/D converter, 10 bit LTC1199 | 544-2031-005 |
| U 010 | Op amp, dual OPA2340 | 544-2018-015 |
| U 011 | Buffer, quad 74LCX125 | 544-3776-127 |
| U 012 | Programmable logic | 544-5001-418 |
| U 016 | EEPROM 32k x 8 M24256 | 544-1019-376 |
| U 017 | Op amp, quad OPA4340 | 544-2020-013 |
| U 018 | Op amp, quad OPA340 | 544-2020-023 |
| U 019 | Op amp, quad OPA4340 | 544-2020-013 |
| U 020 | Op amp, quad OPA340 | 544-2020-023 |
| U 021 | Audio amp, 750 mW LM4865 | 544-2006-028 |
| U 024 | Analog switch, SPDT NLAS4599 | 544-4002-007 |
| U 026 | Triple supply monitor LT1727 | 544-5001-341 |
| U 027 | Serial bus USB xcvr USBIT11AM | 544-3014-161 |
| U 033 | Buffer, 3-state 3.3V | 544-3914-125 |
| U 034 | Diff comparator, dual TLC3521D | 544-2025-021 |
| U 036 | RS-232 bus xcvr MAX3221EAE | 544-2023-036 |
| Y 001 | Crystal, 4.9152 MHz | 521-3060-022 |
| Y 002 | Osc, 1 kHz to 30 MHz resistor set | 521-9004-701 |

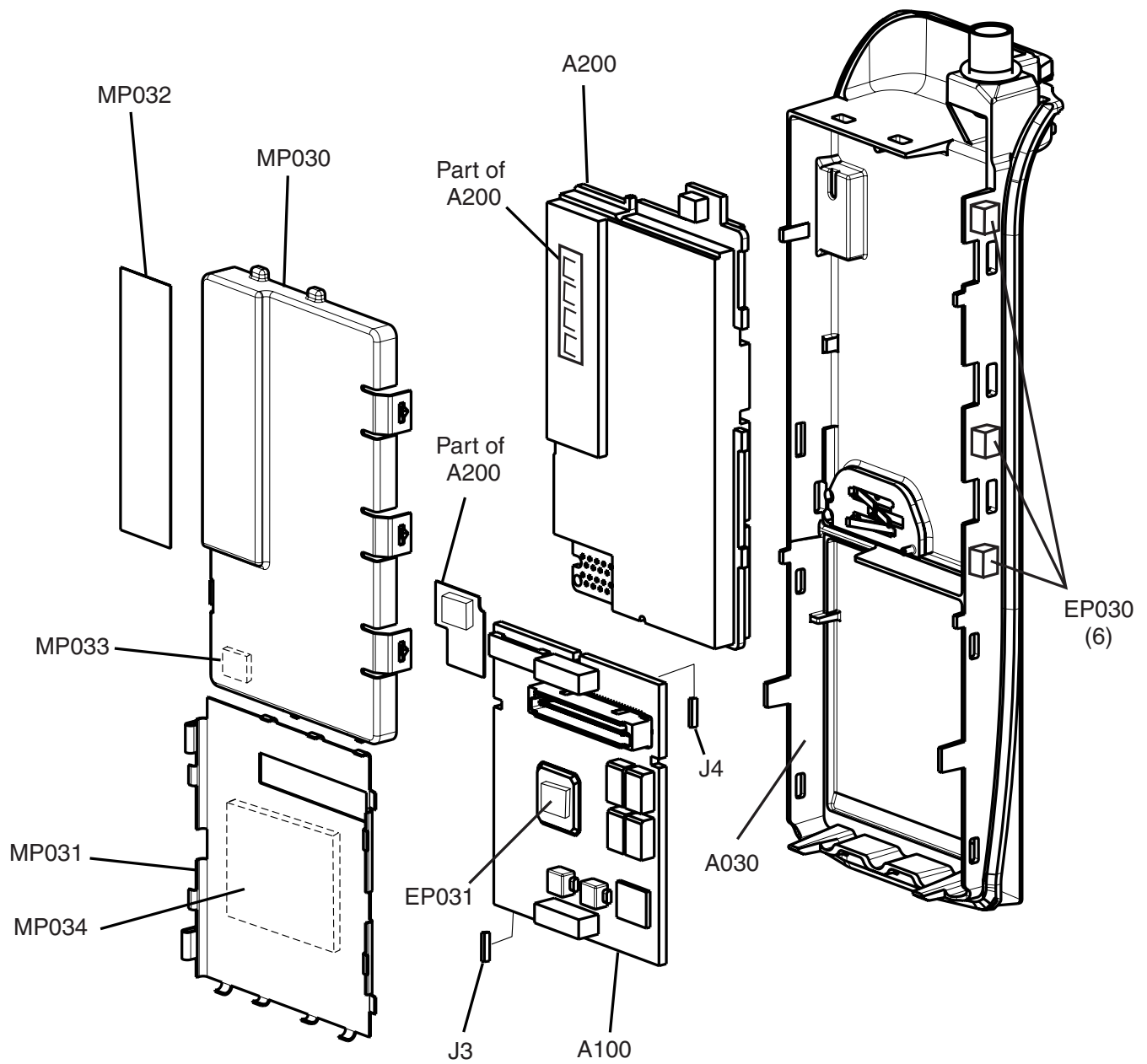
EXPLODED VIEWS



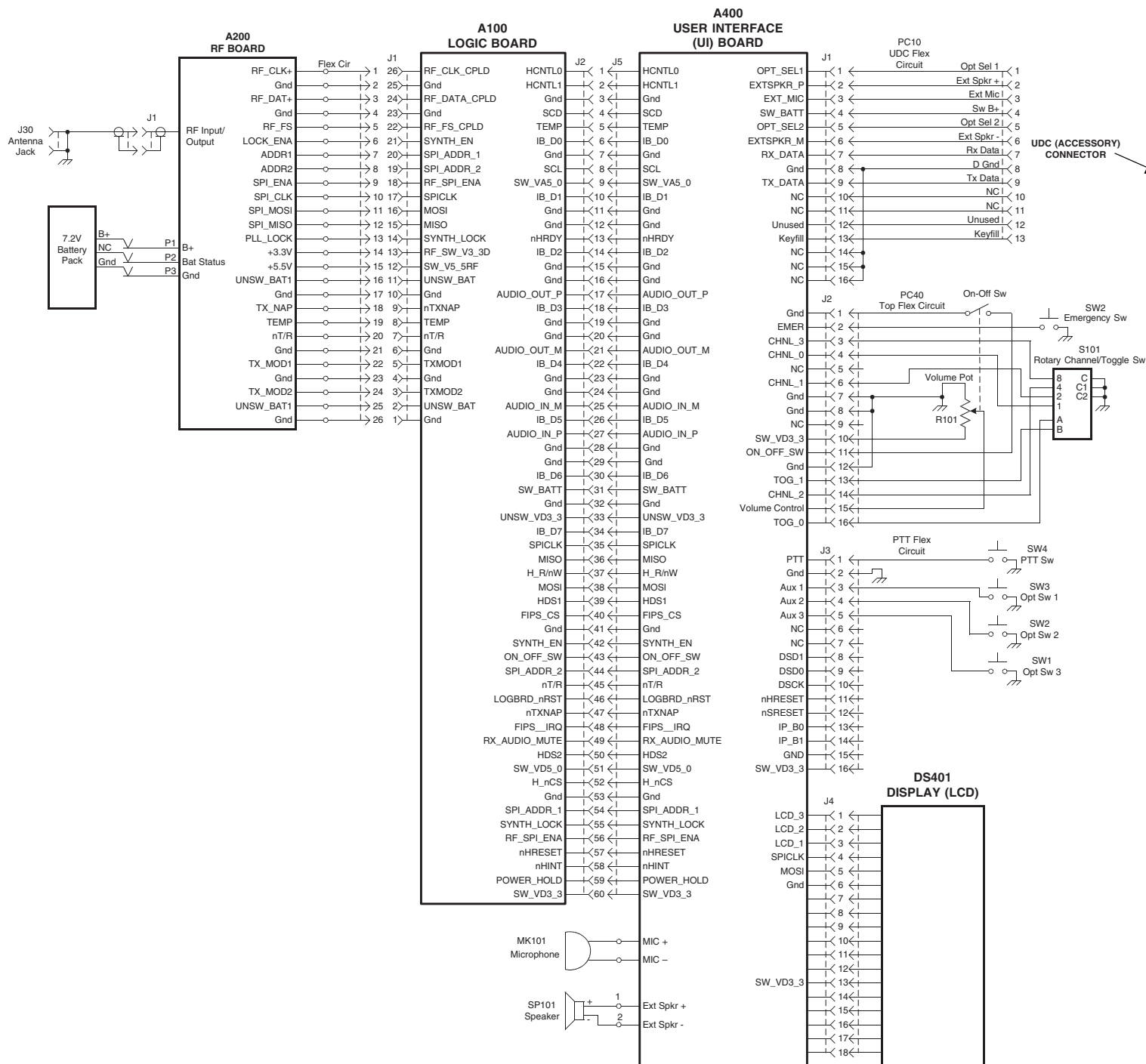
Front Cover Assembly

**Top Switch Assembly****Rear Housing Assembly**

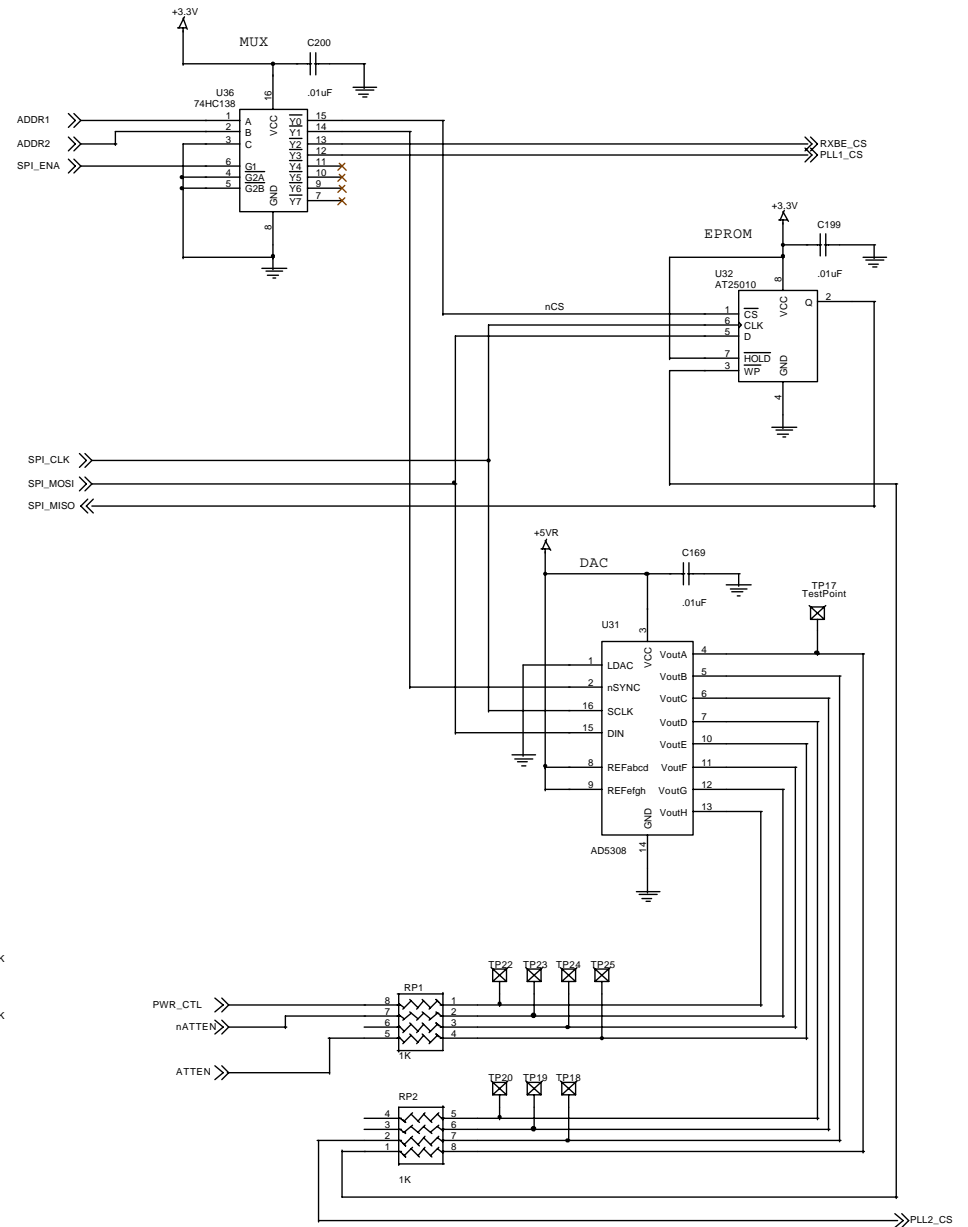
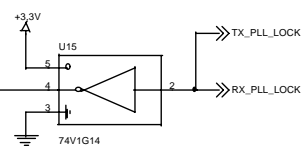
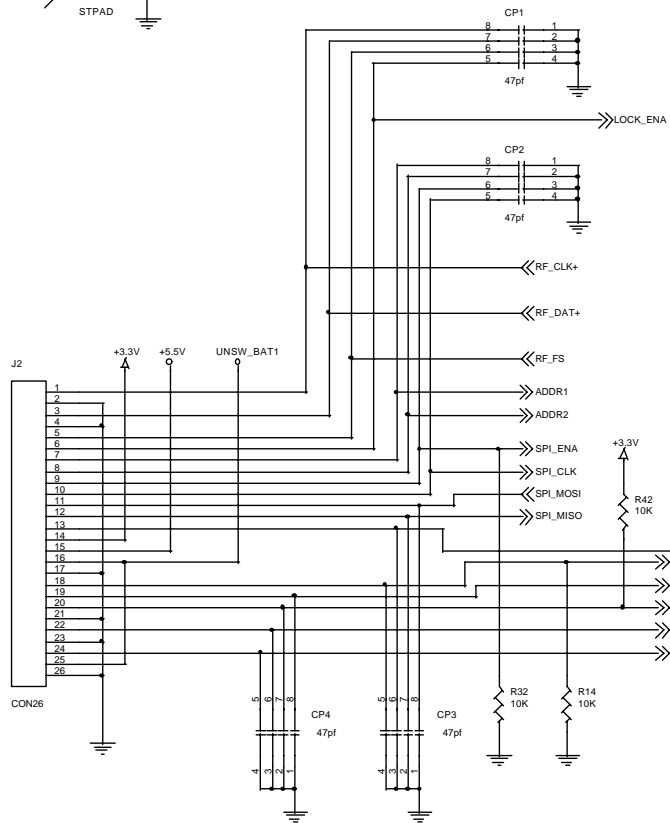
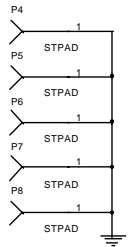
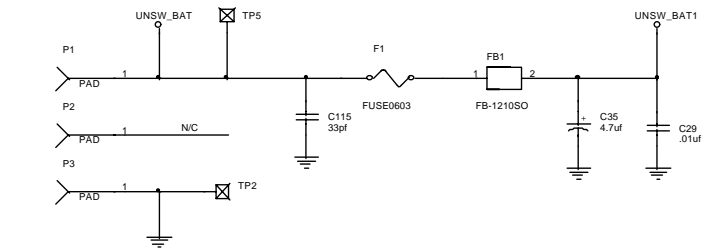




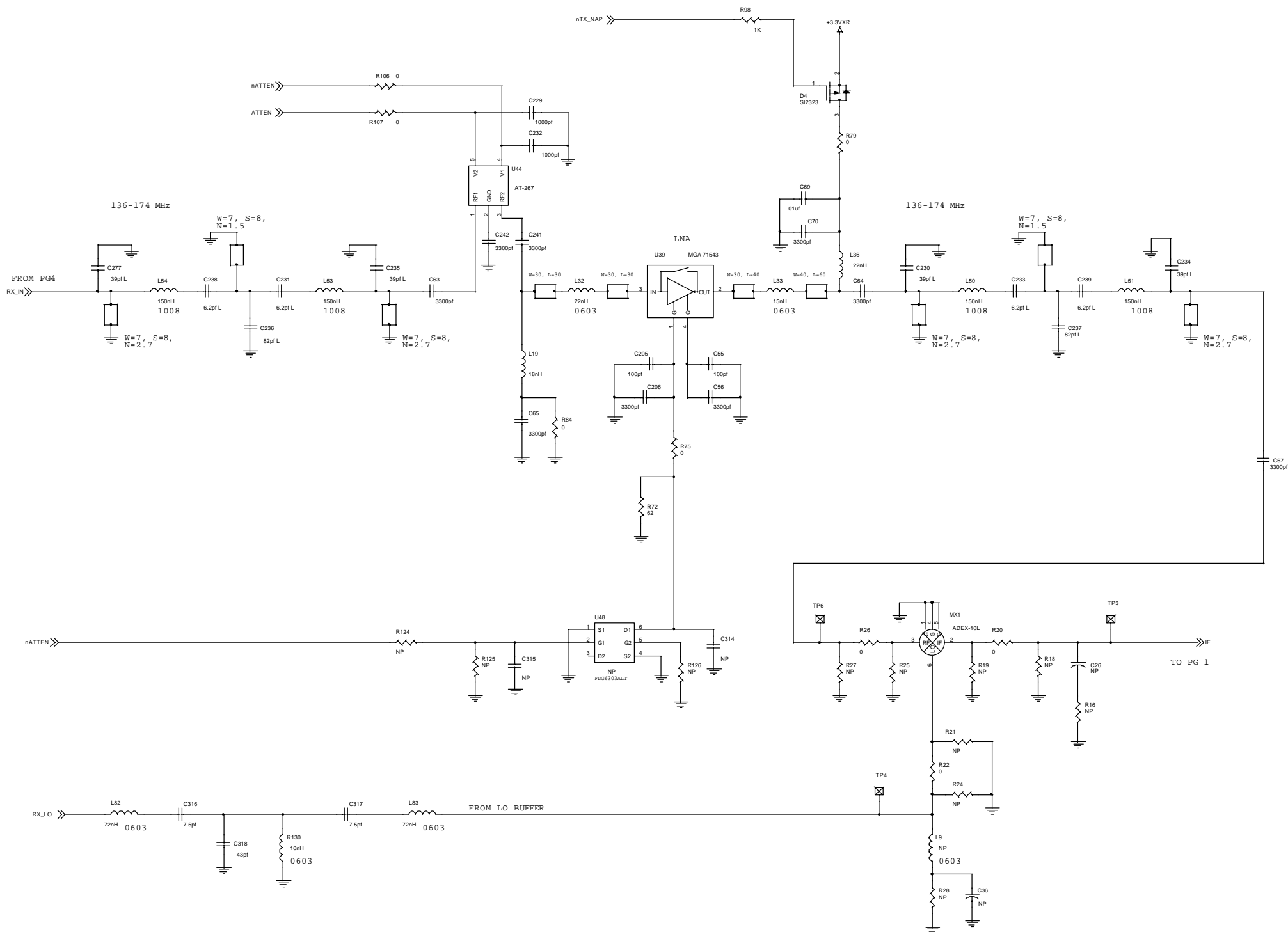
SECTION 8 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

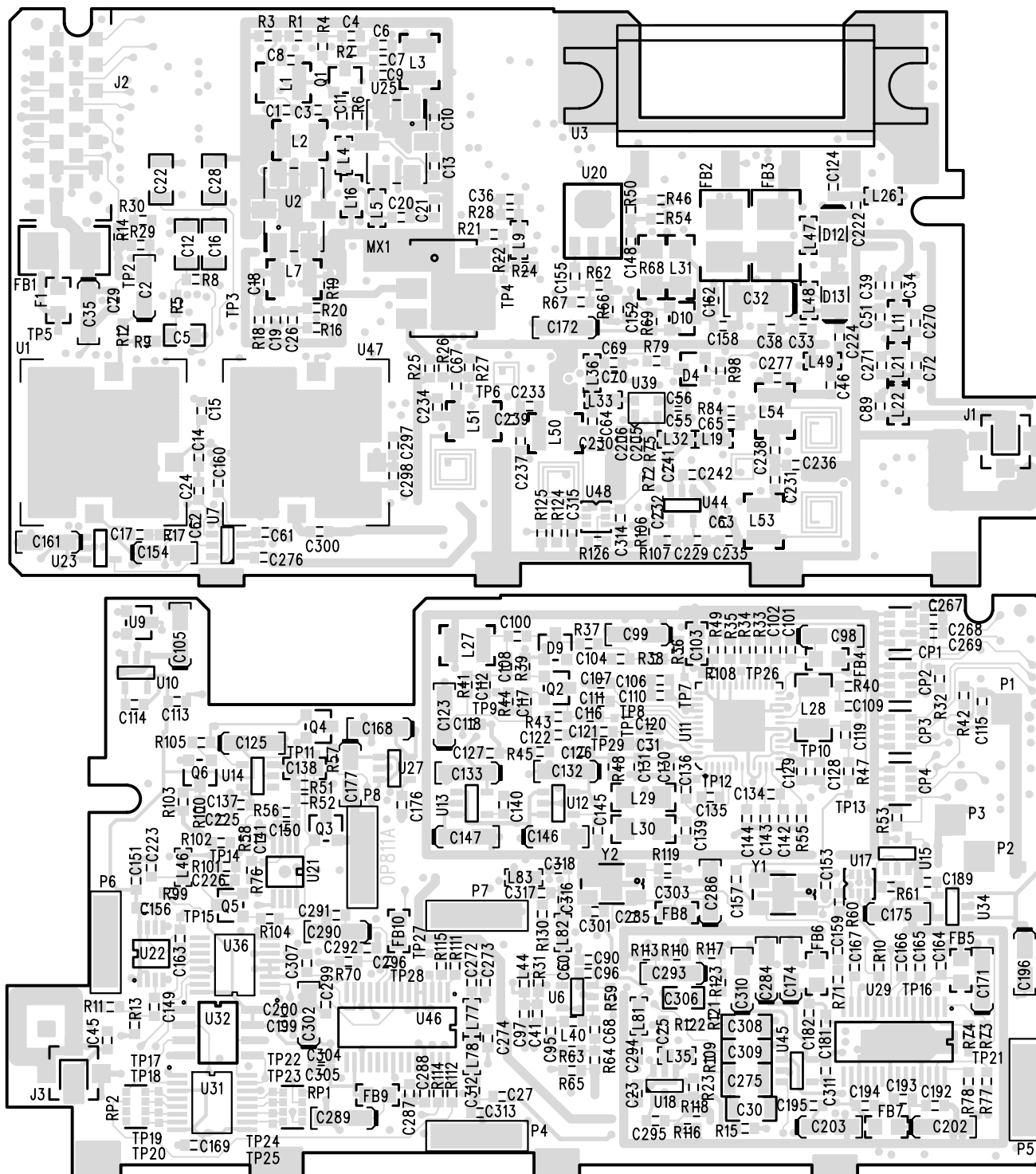


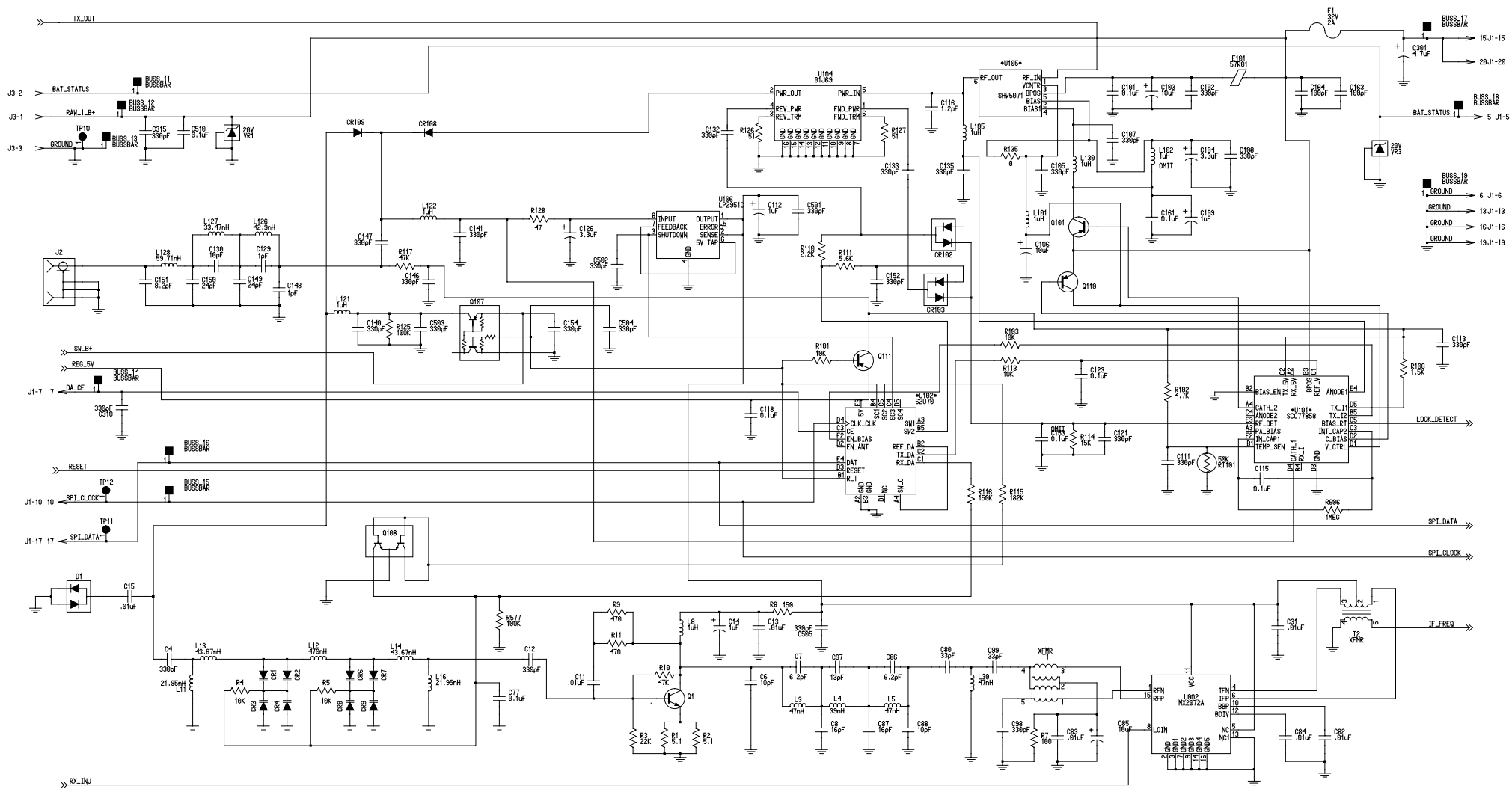






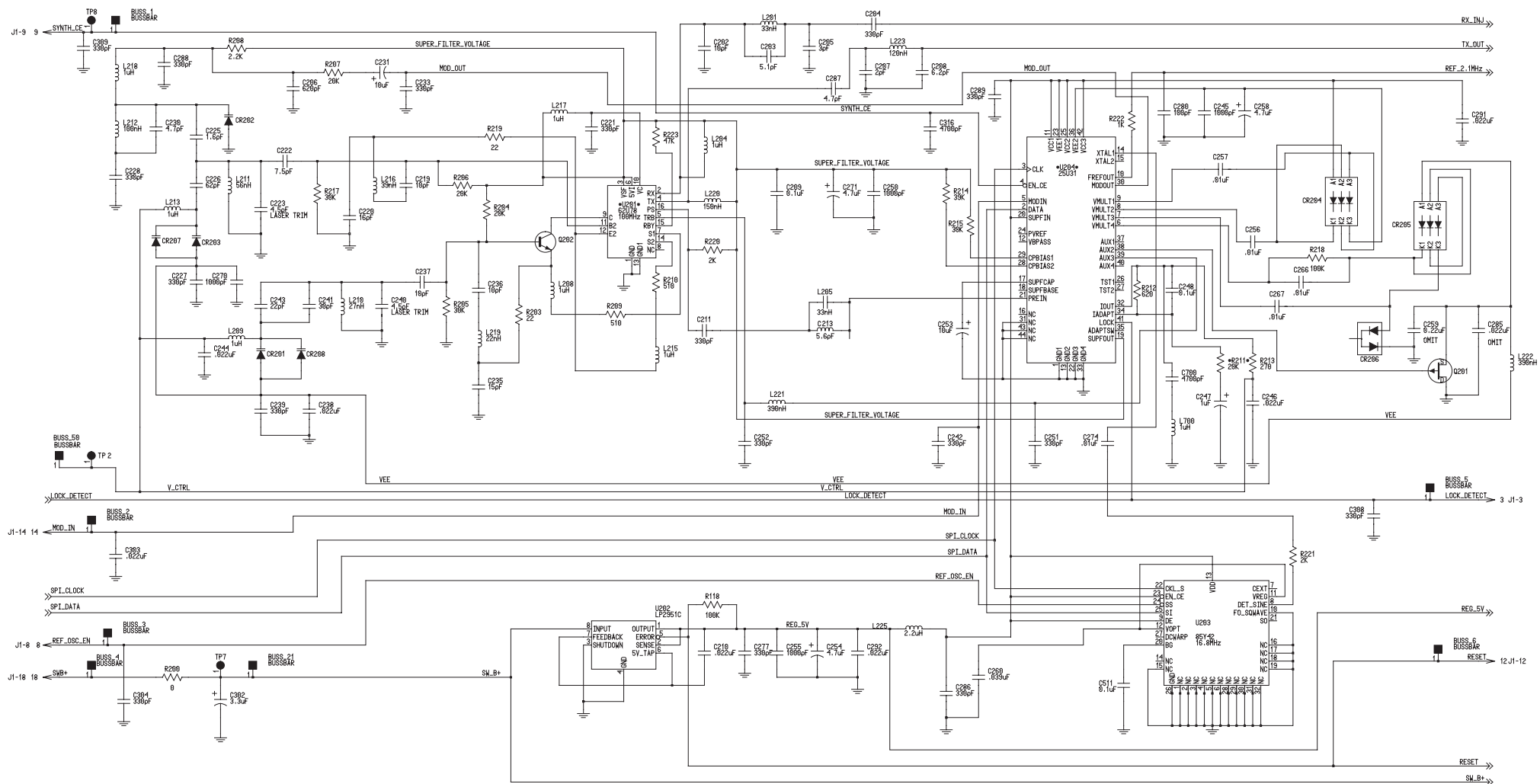




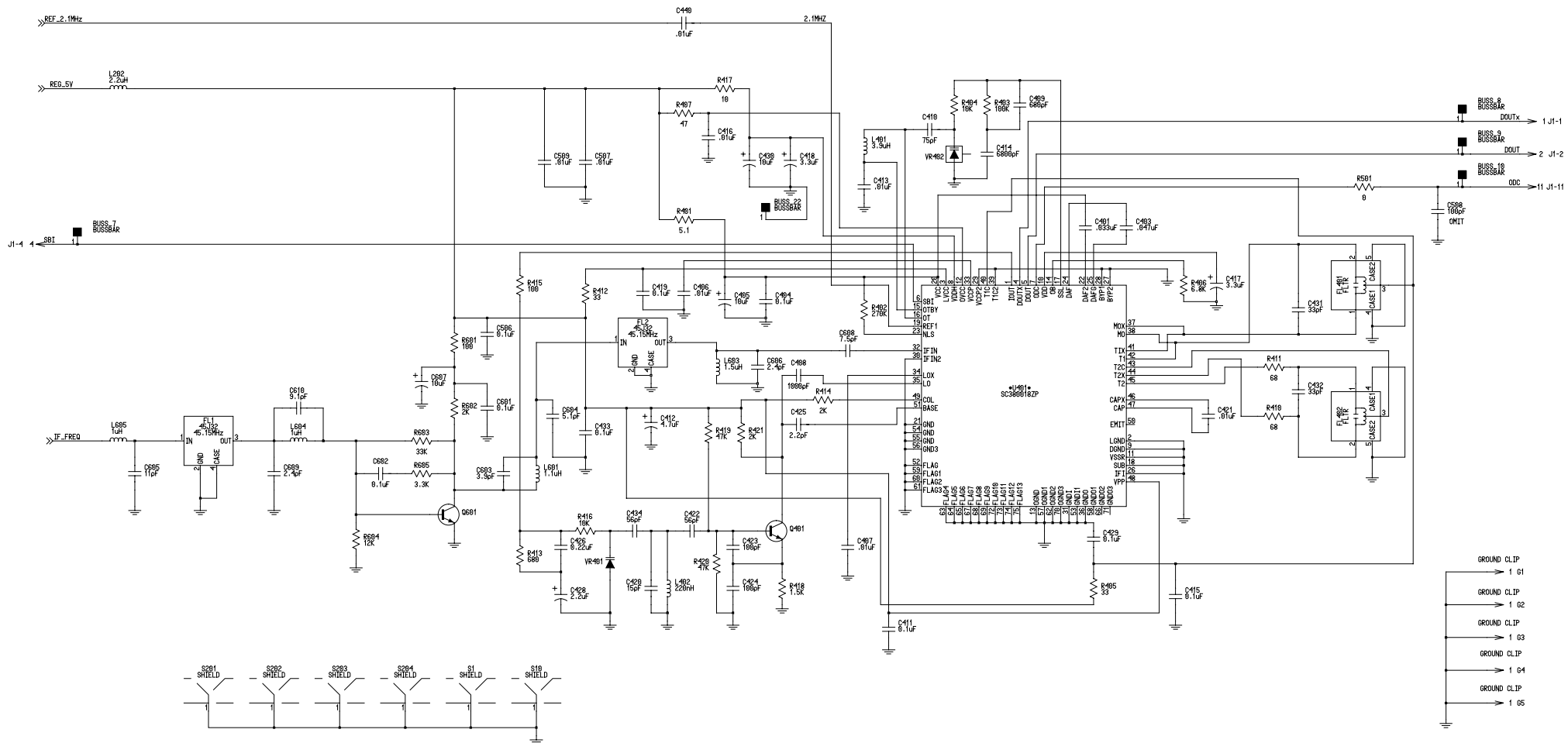


NOTE: Individual replacement parts are not available for the RF board, so the entire board must be replaced if it is defective.

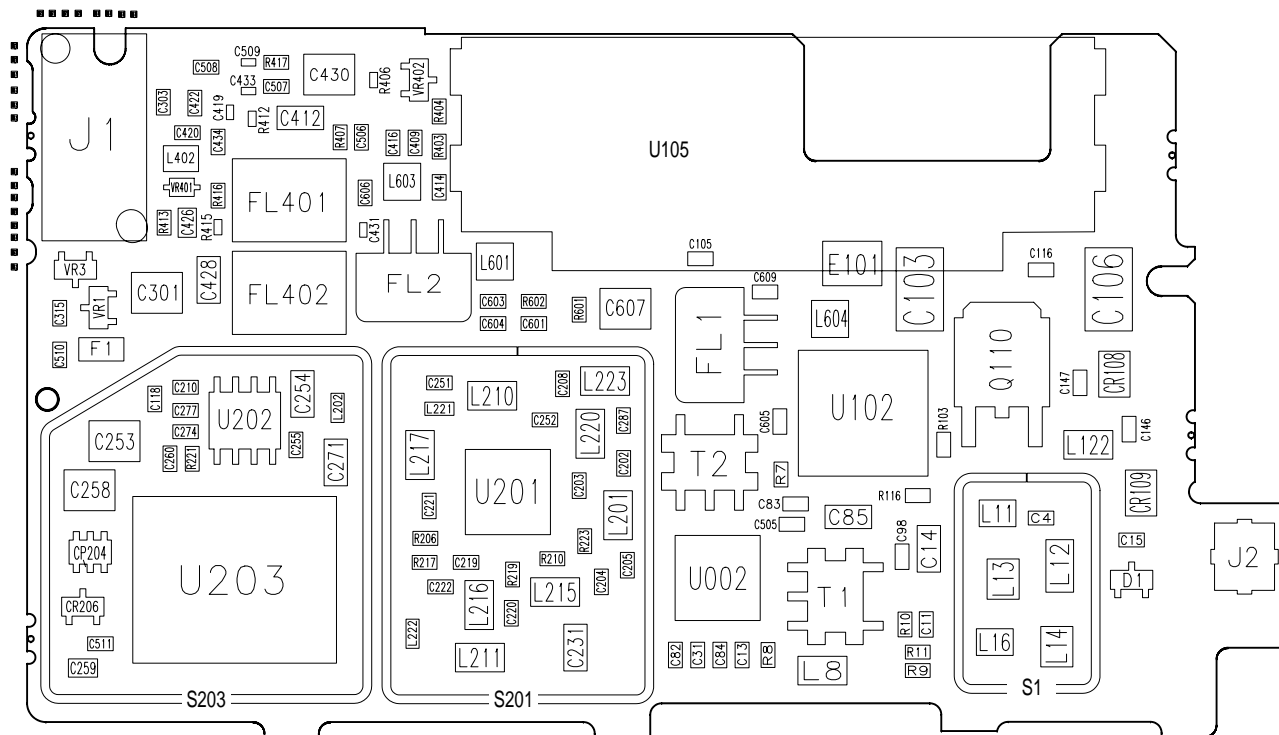
VHF RF BOARD SCHEMATIC VER B (PAGE 1 OF 3)



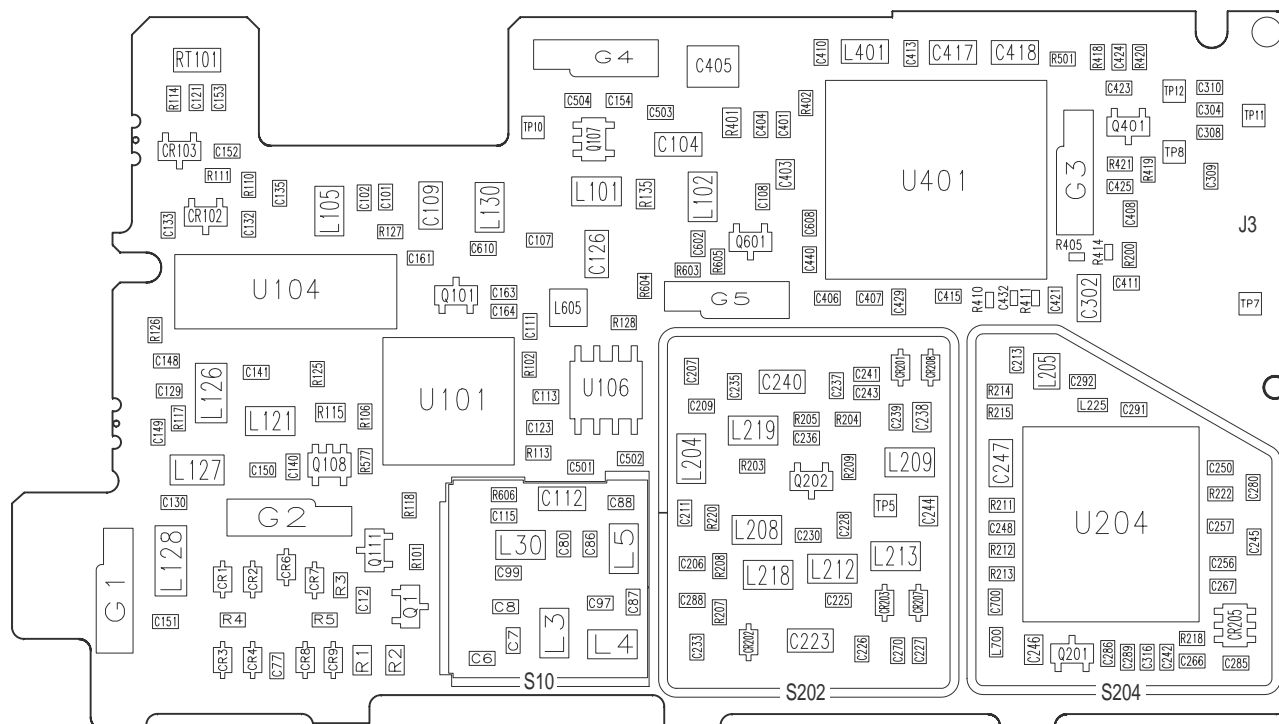
VHF RF BOARD SCHEMATIC VER B (PAGE 2 OF 3)



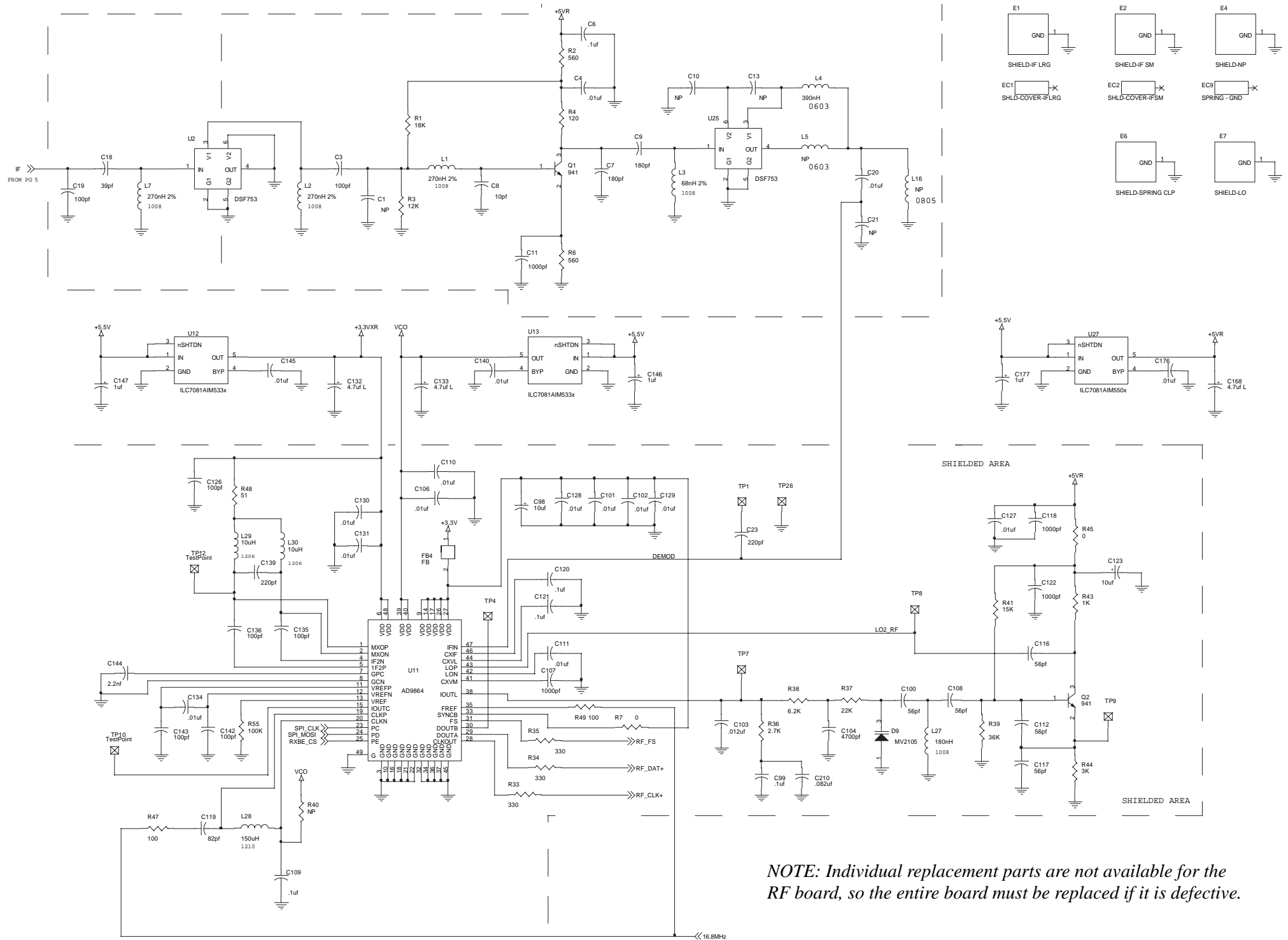
VHF RF BOARD SCHEMATIC VER B (PAGE 3 OF 6)

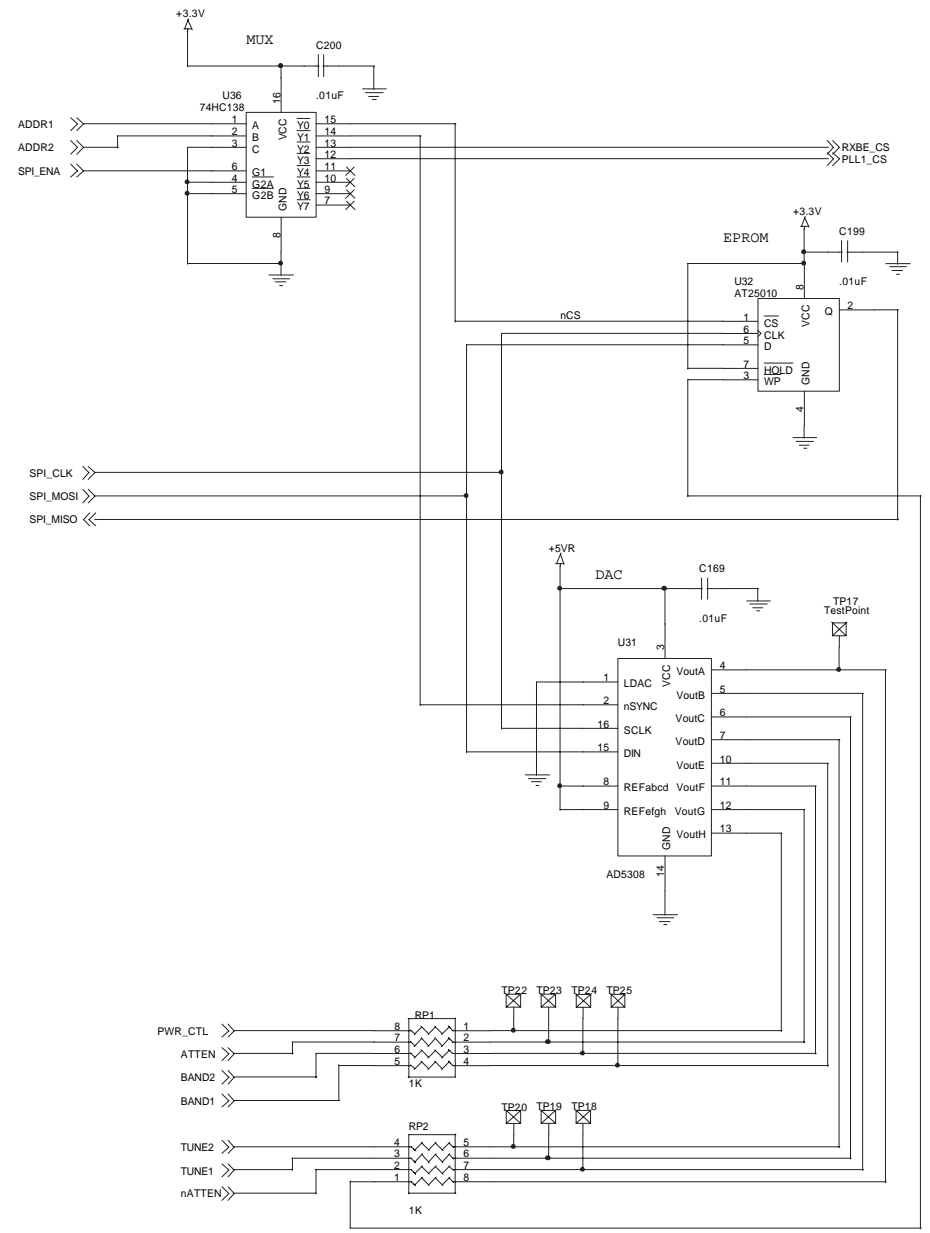
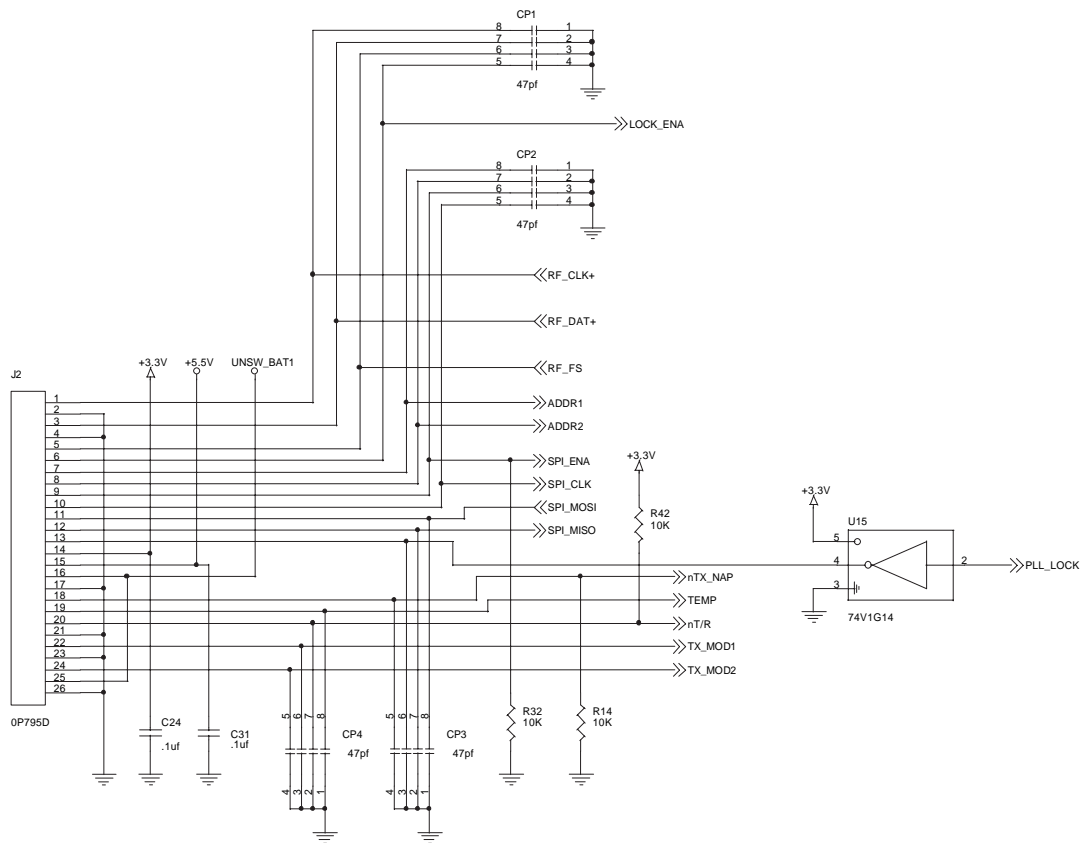
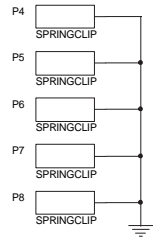
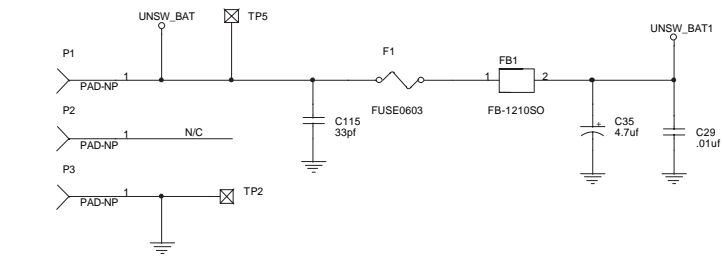


TOP VIEW

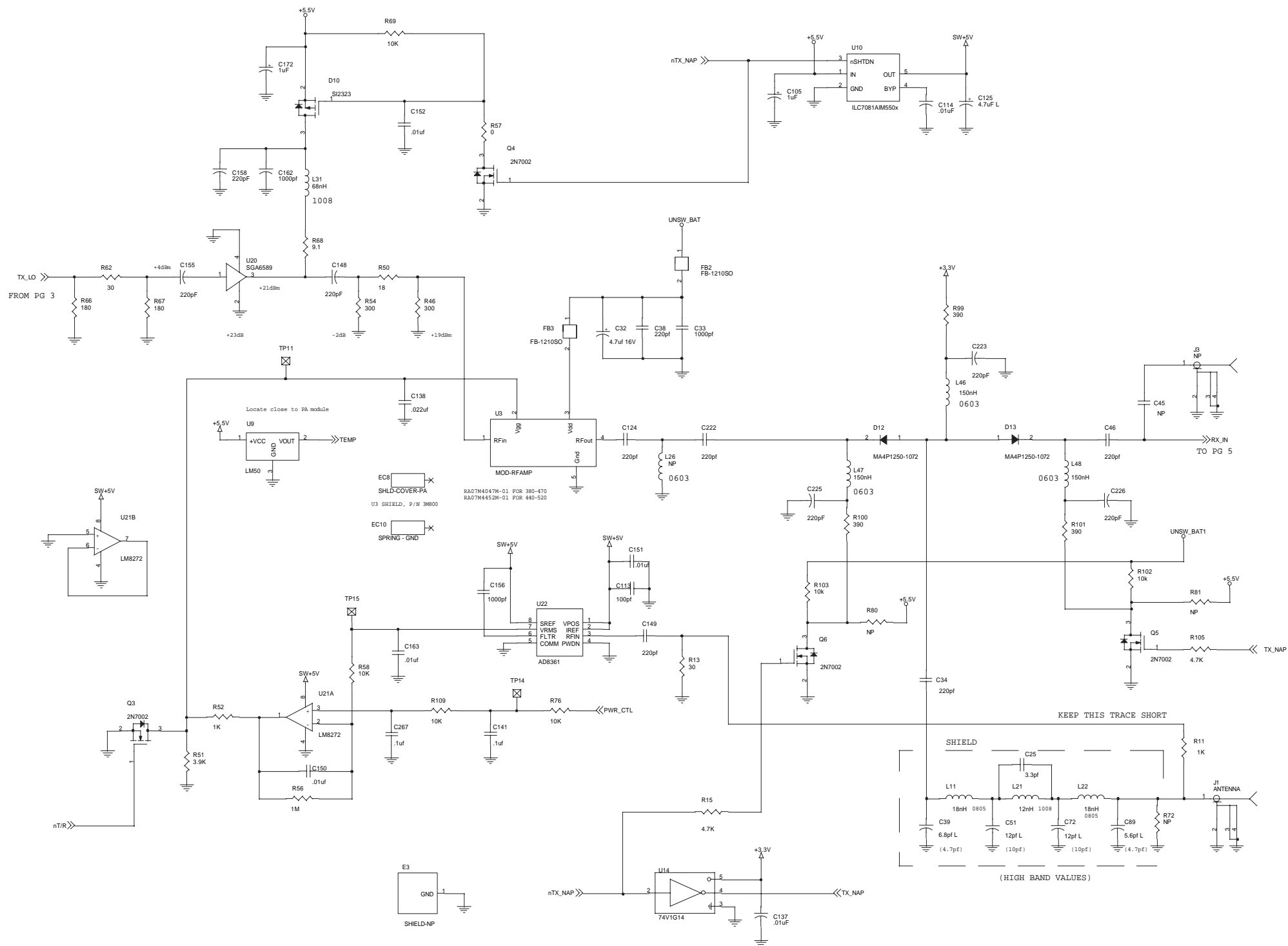


BOTTOM VIEW



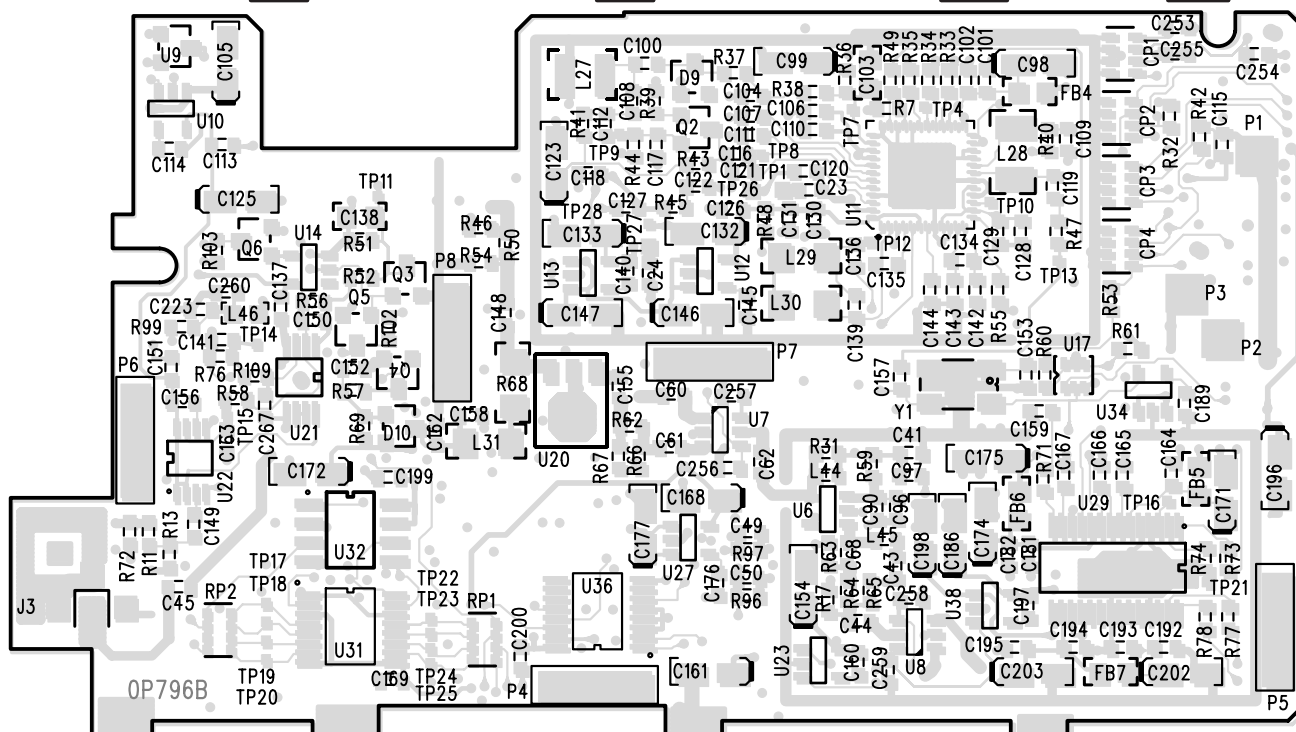






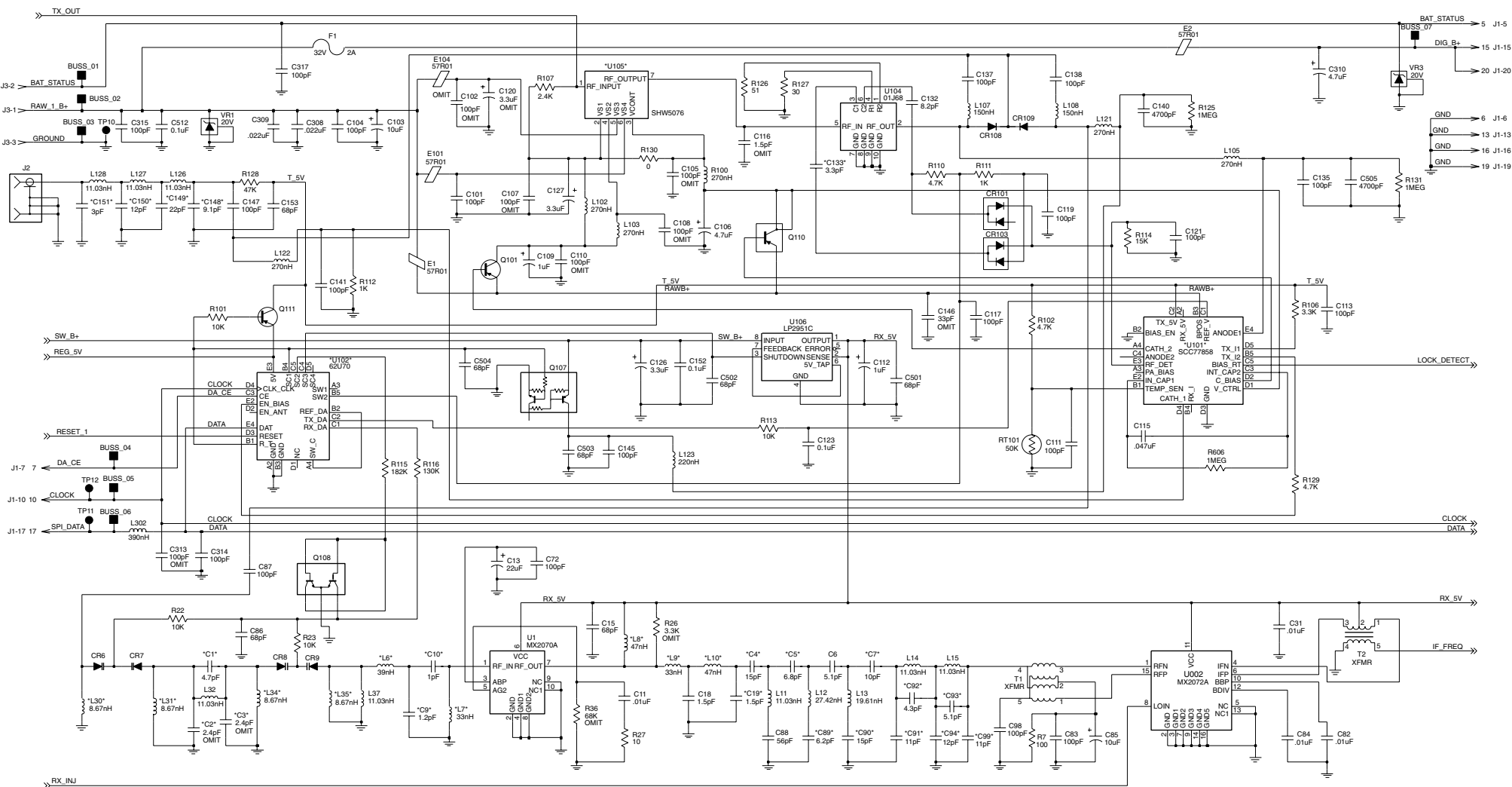


TOP VIEW



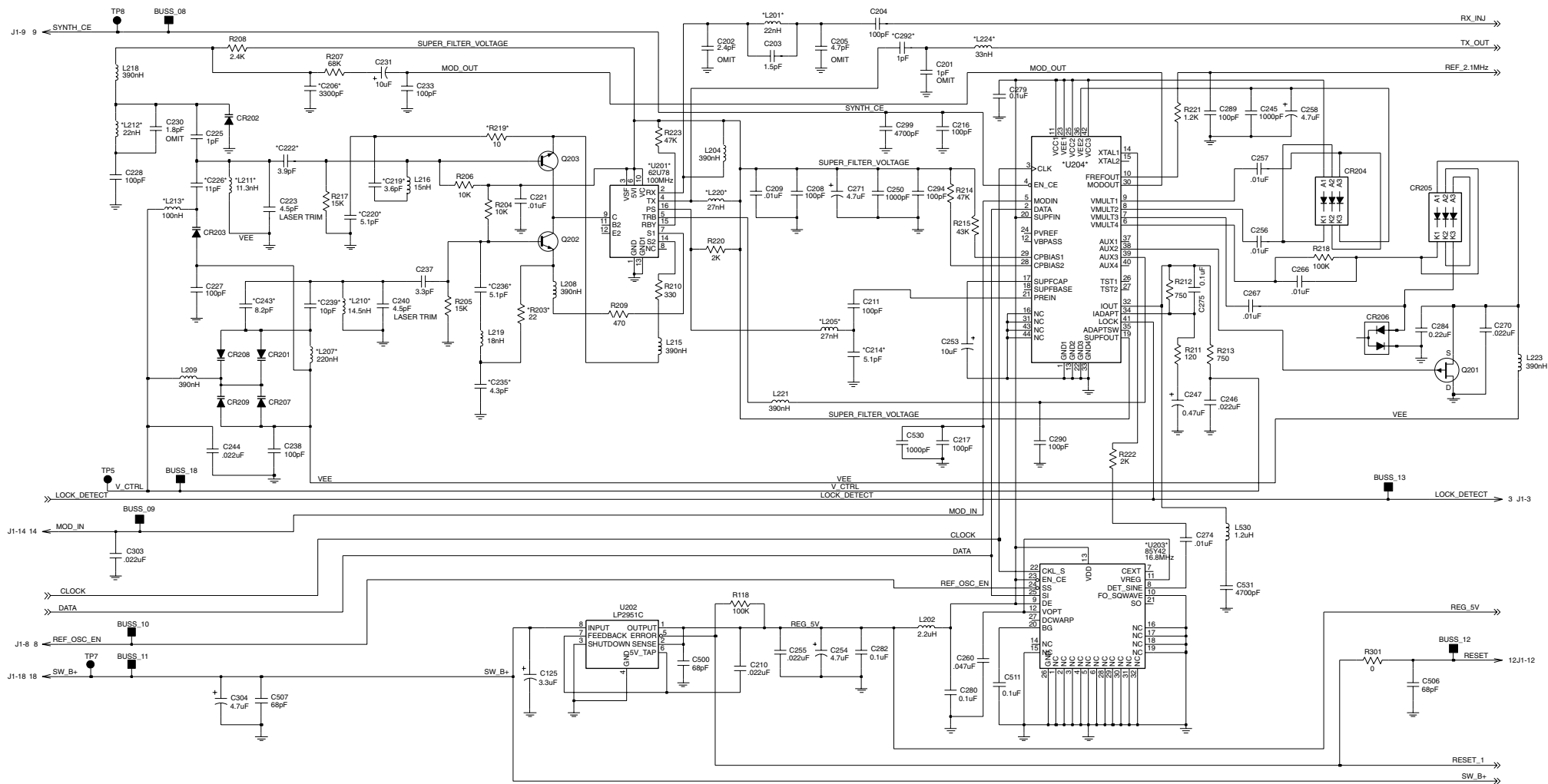
BOTTOM VIEW

UHF RF BOARD VER C LAYOUT



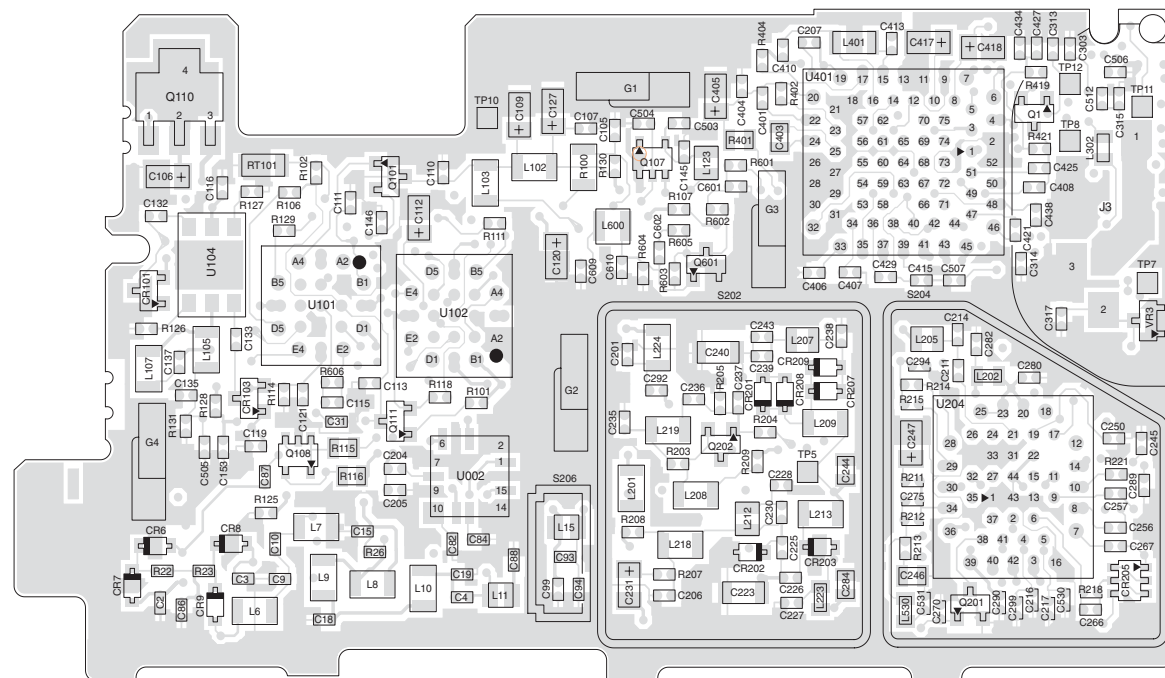
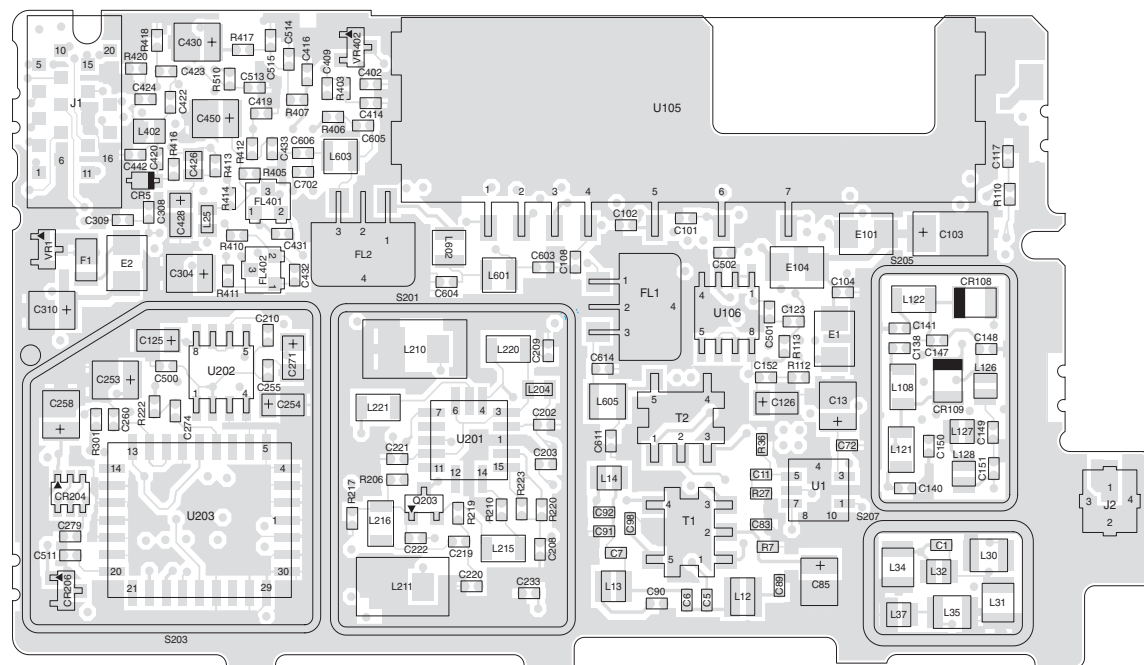
NOTE: Individual replacement parts are not available for the RF board, so the entire board must be replaced if it is defective.

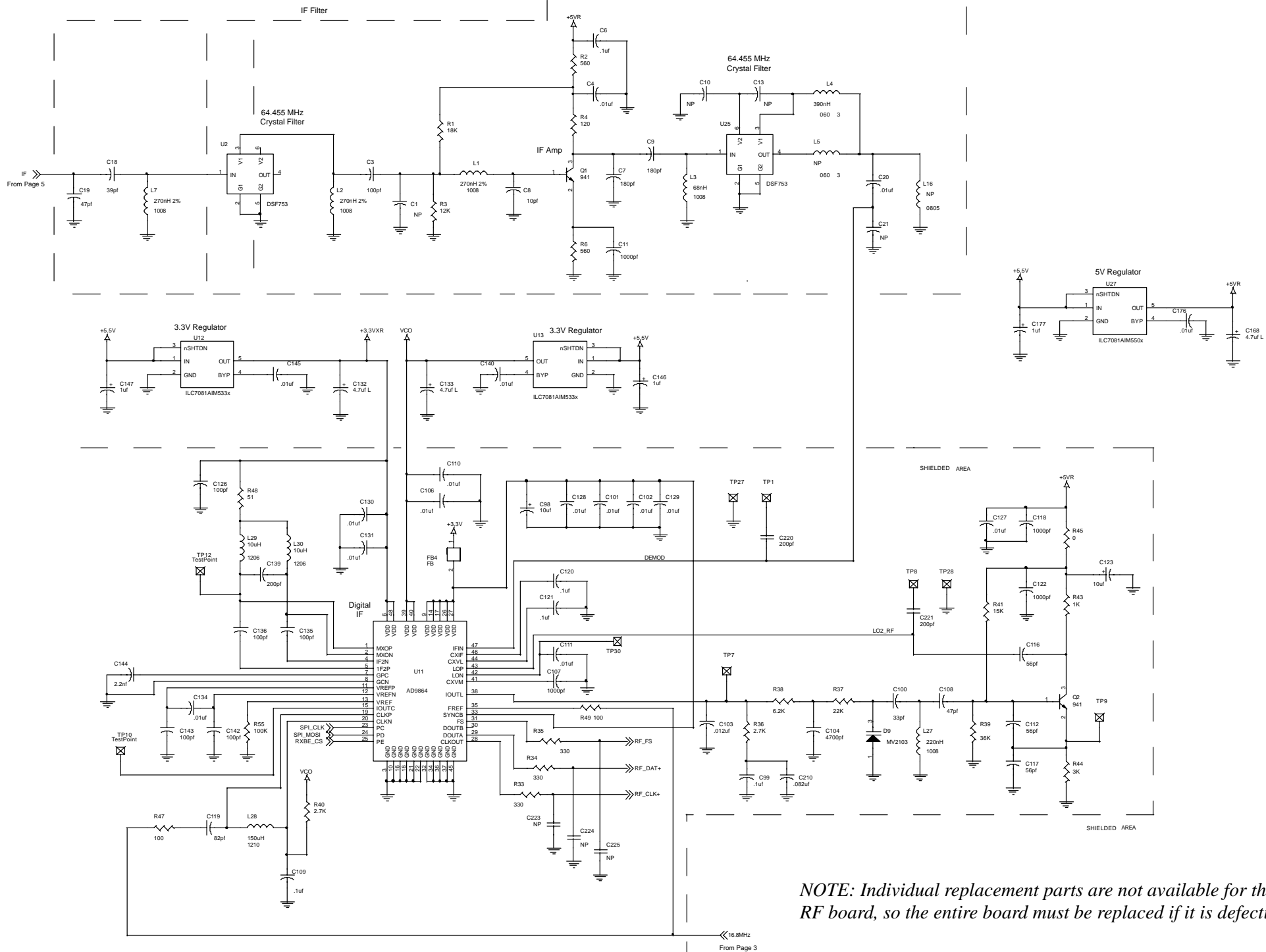
UHF RF BOARD VER A/B SCHEMATIC (PAGE 1 OF 3)

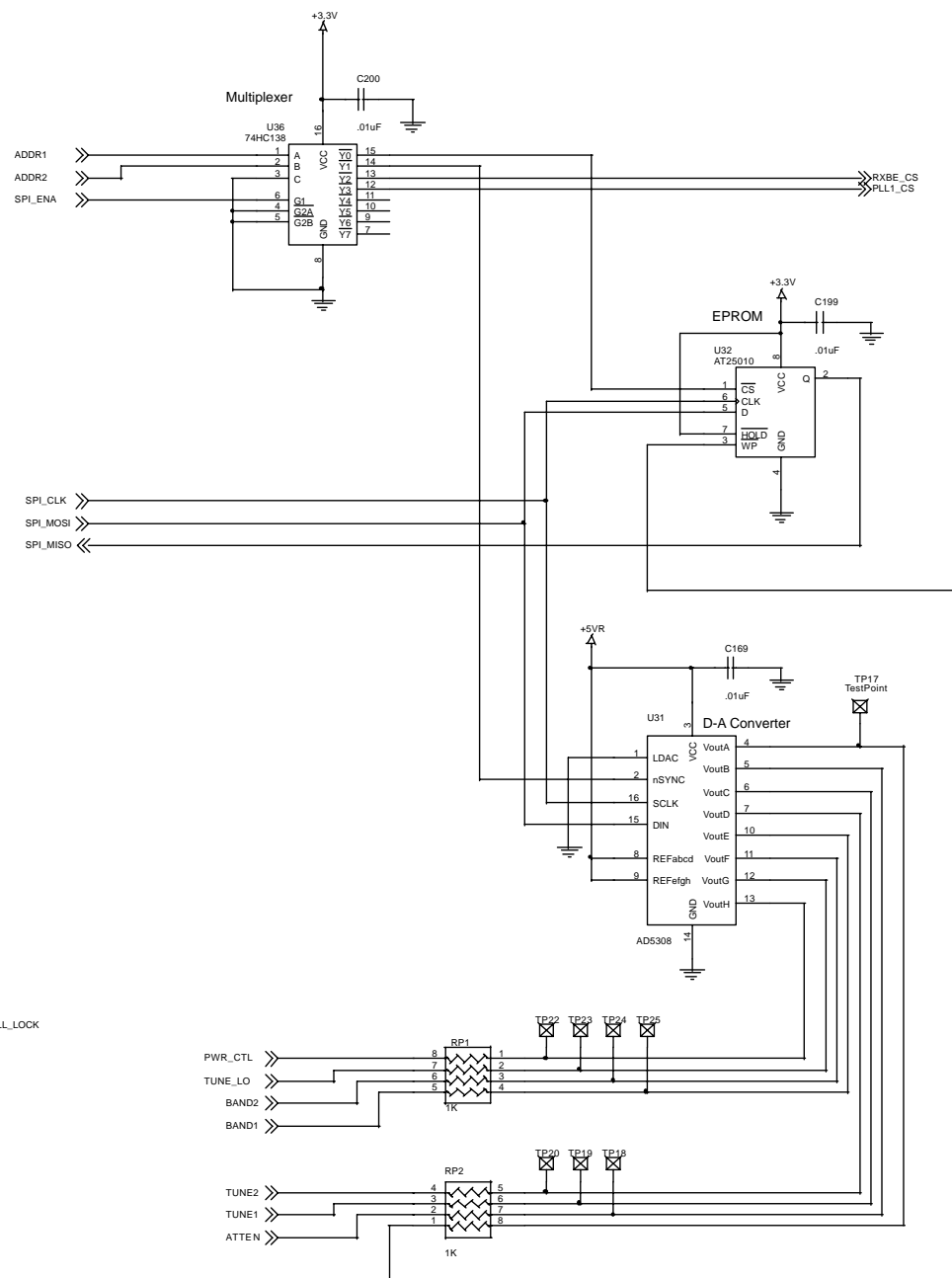
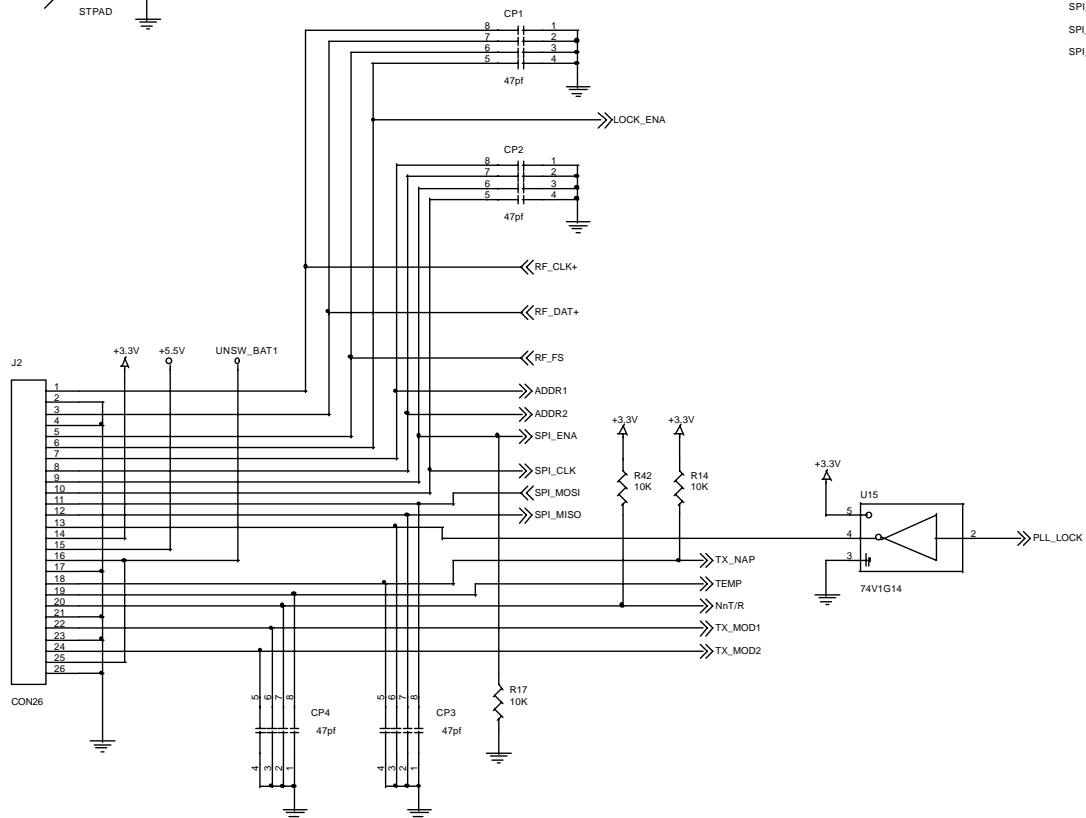
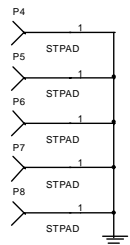
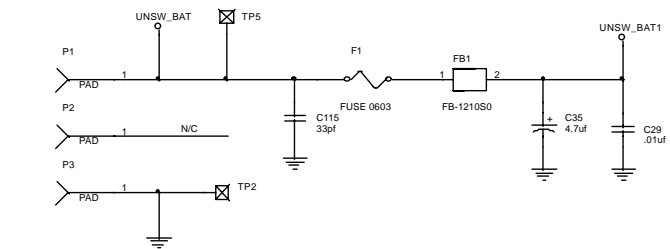


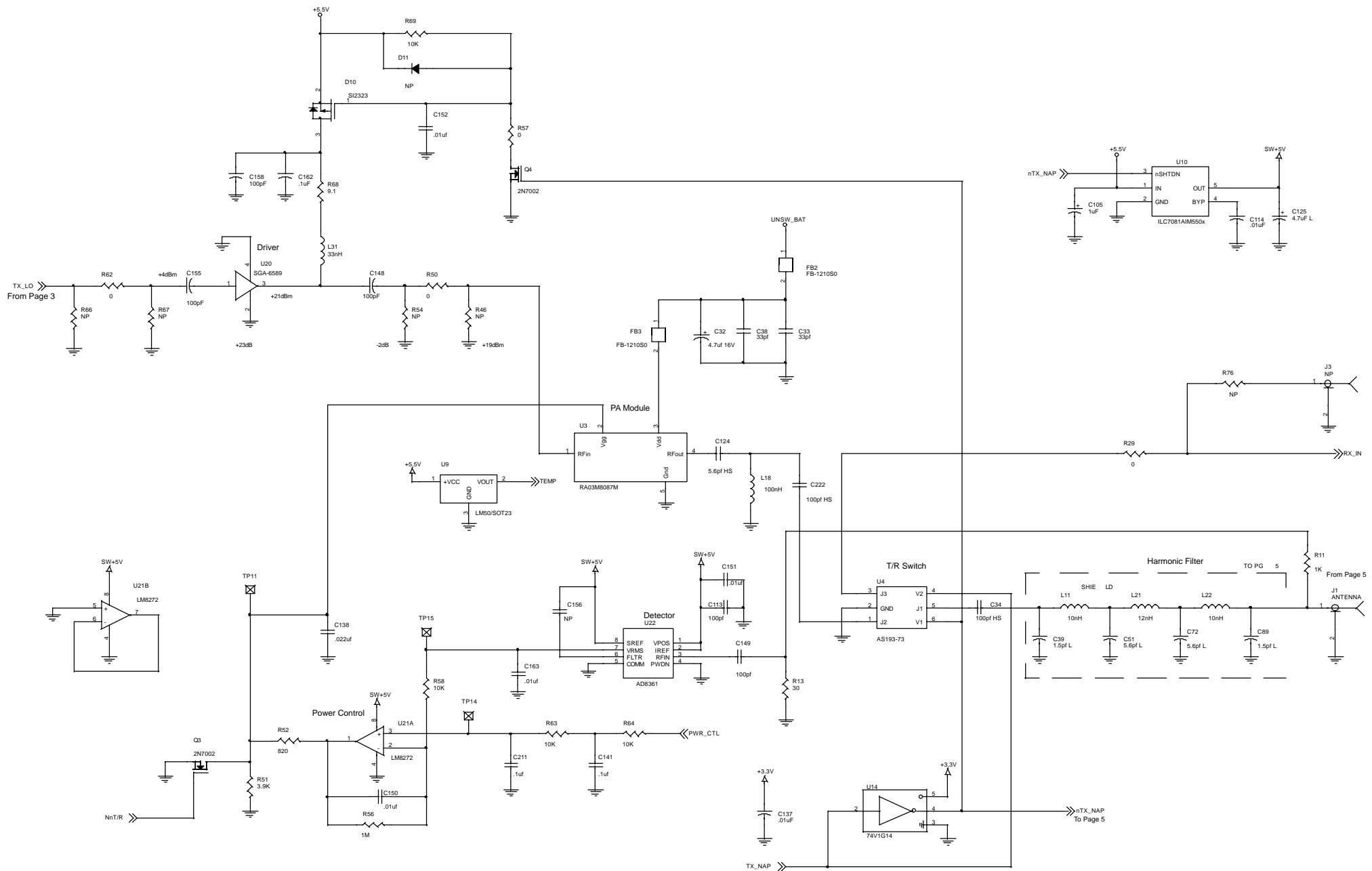
UHF RF BOARD VER A/B SCHEMATIC (PAGE 2 OF 3)

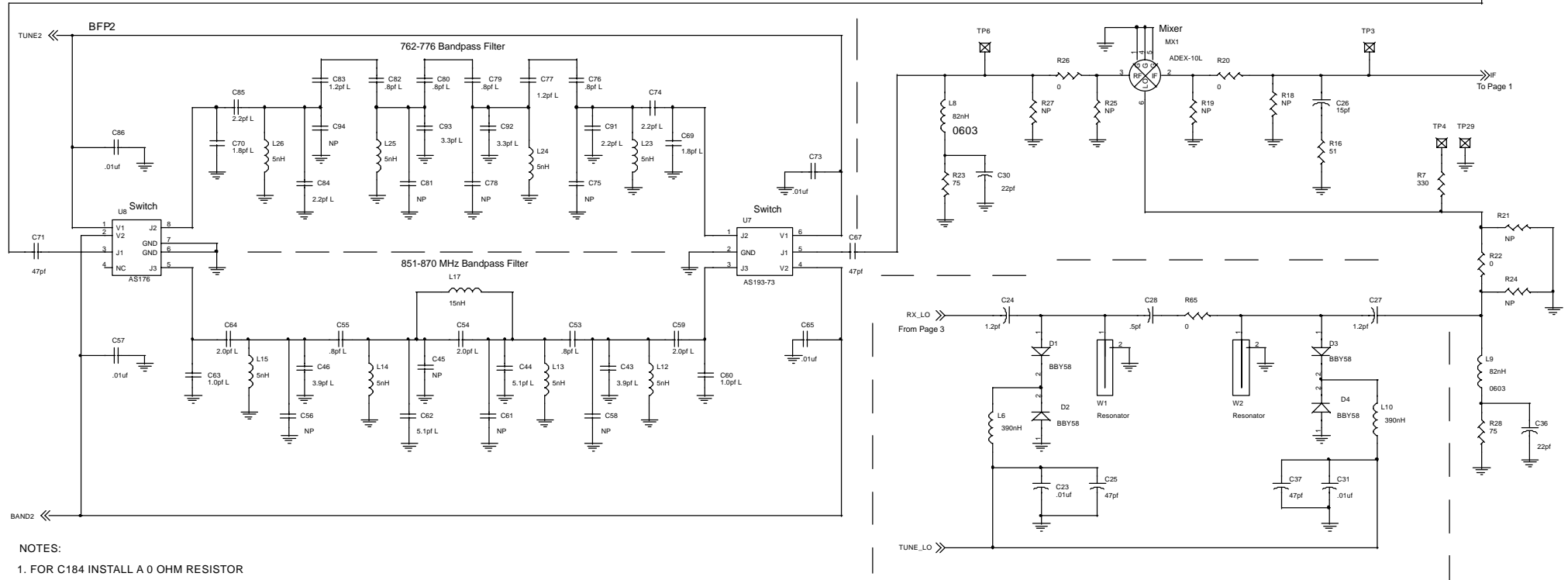
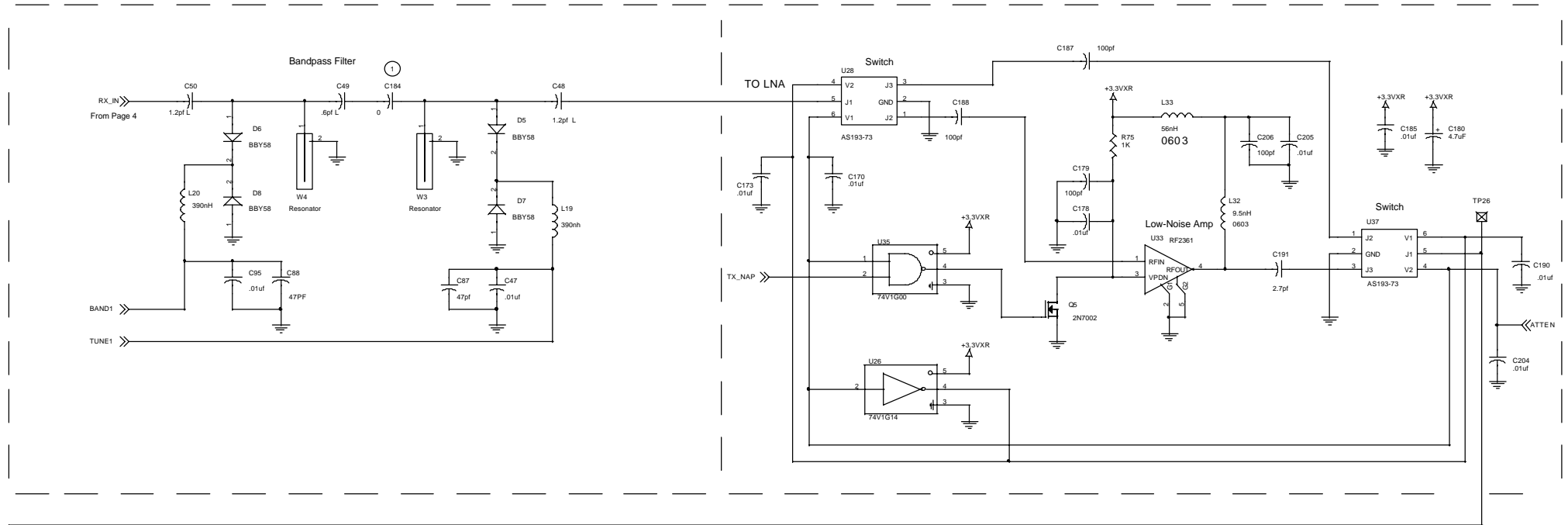
8-22

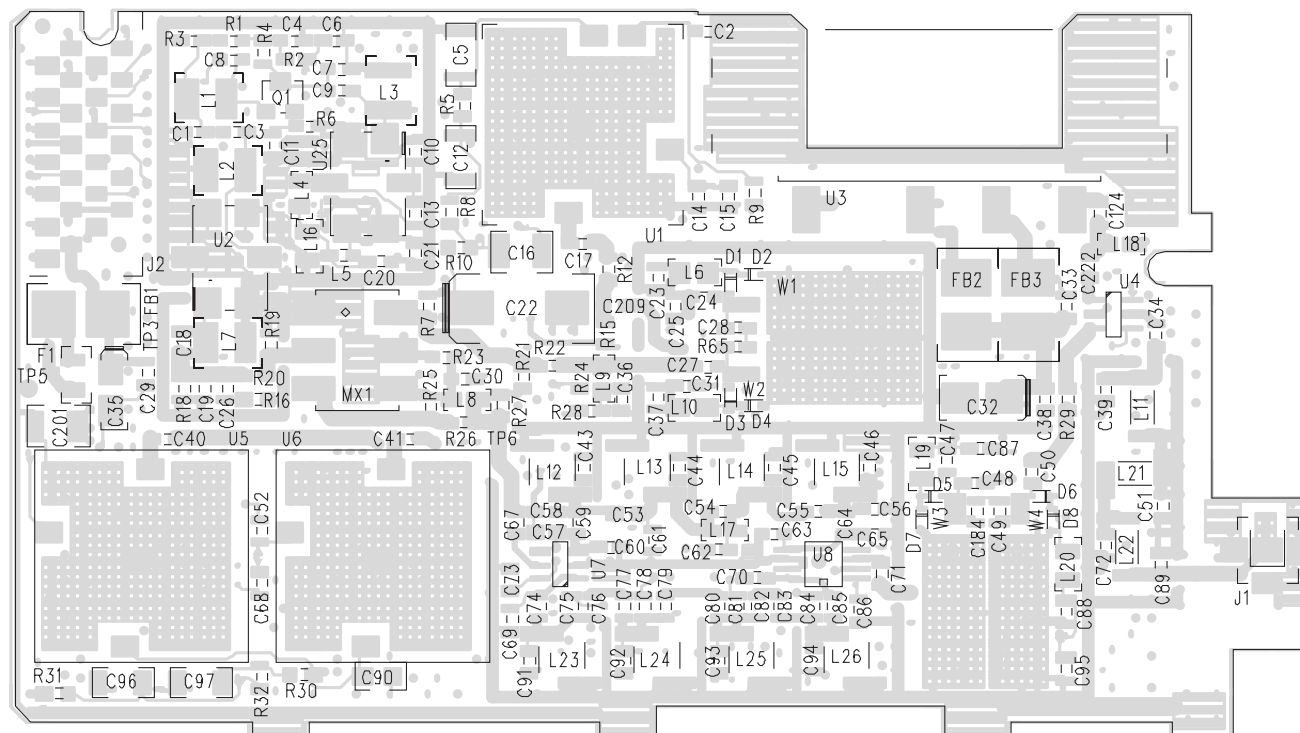




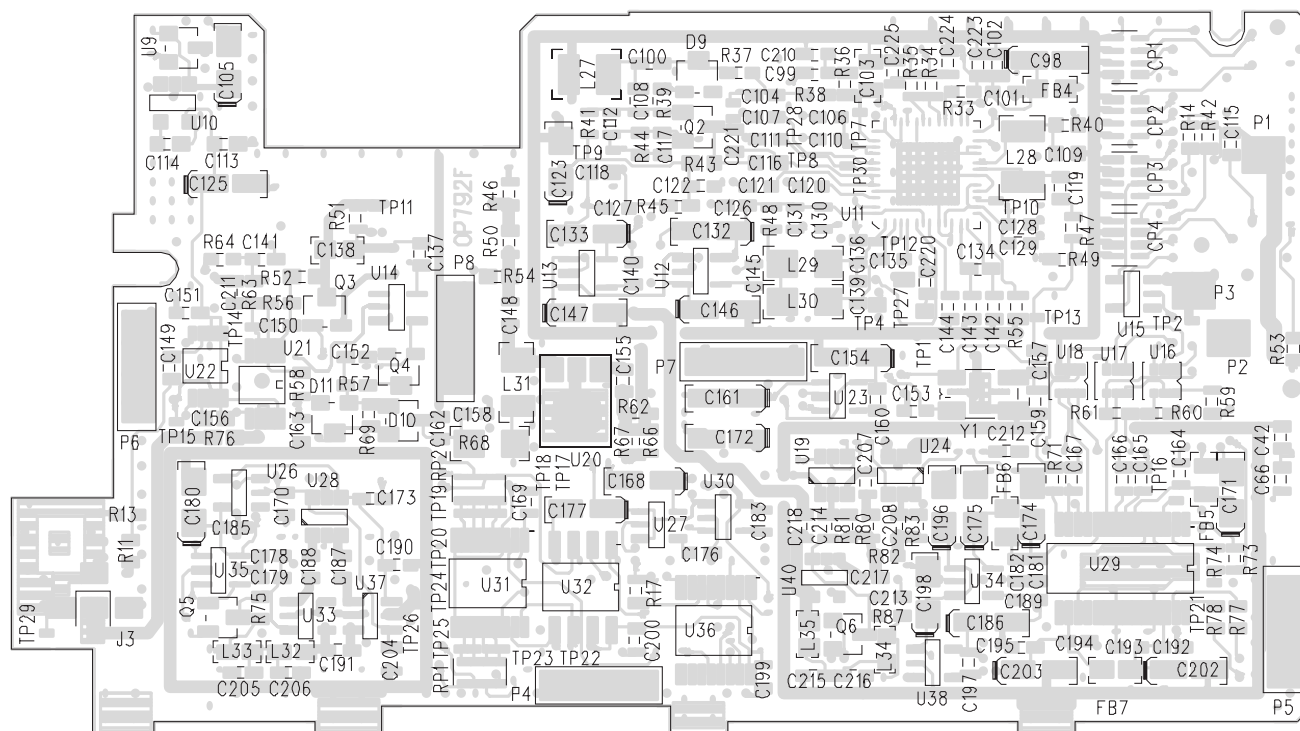




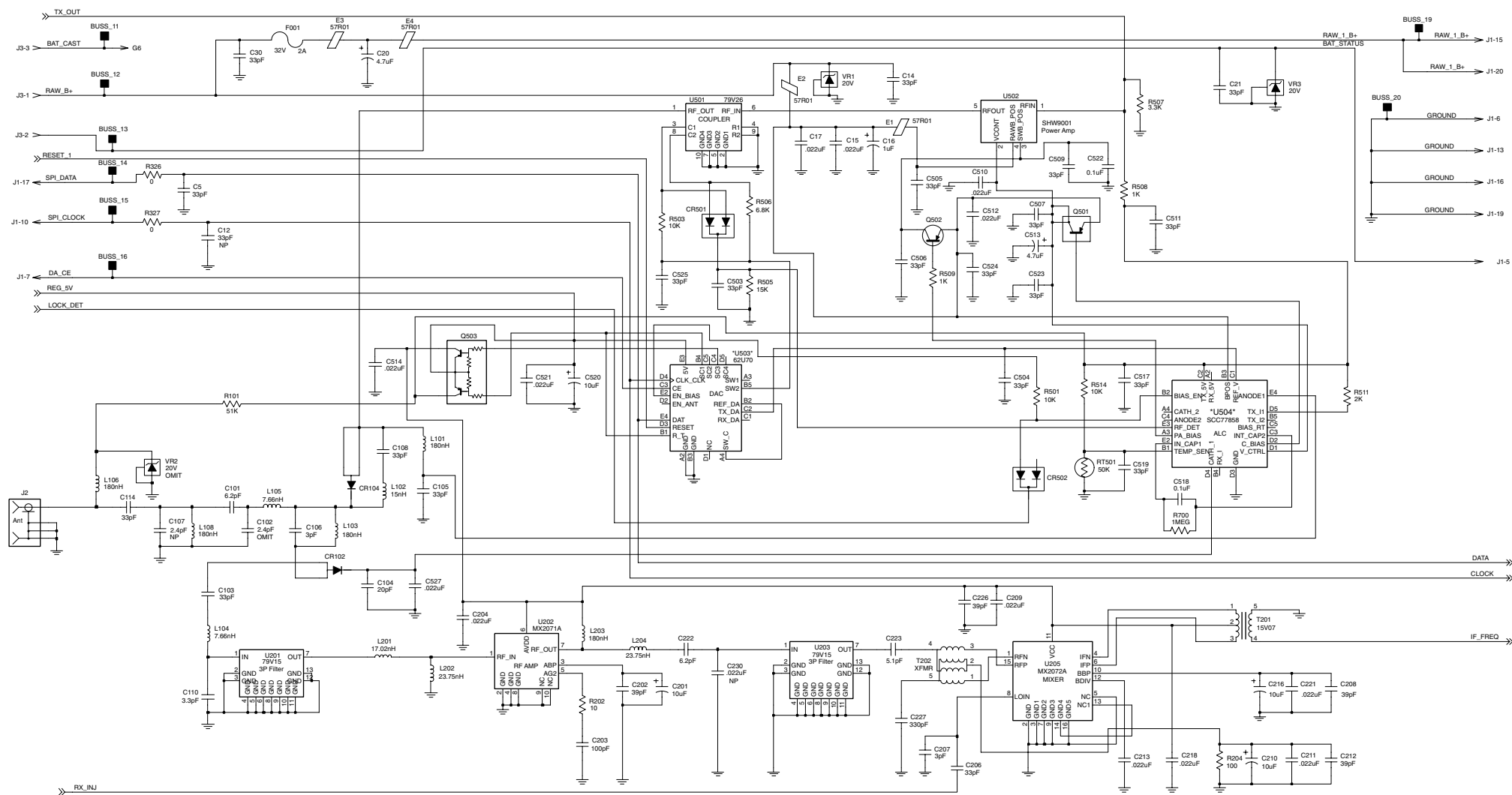




TOP VIEW

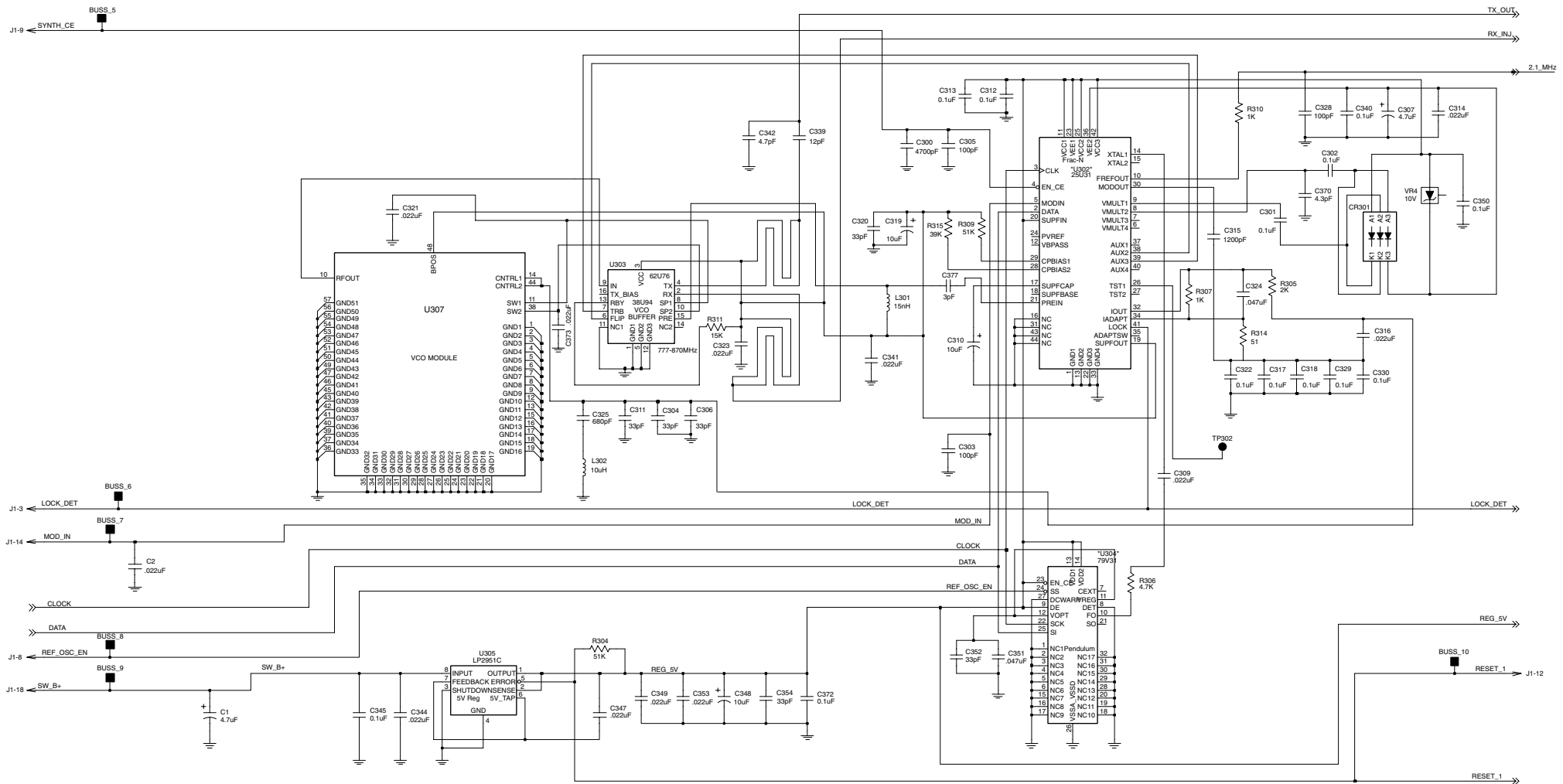


BOTTOM VIEW

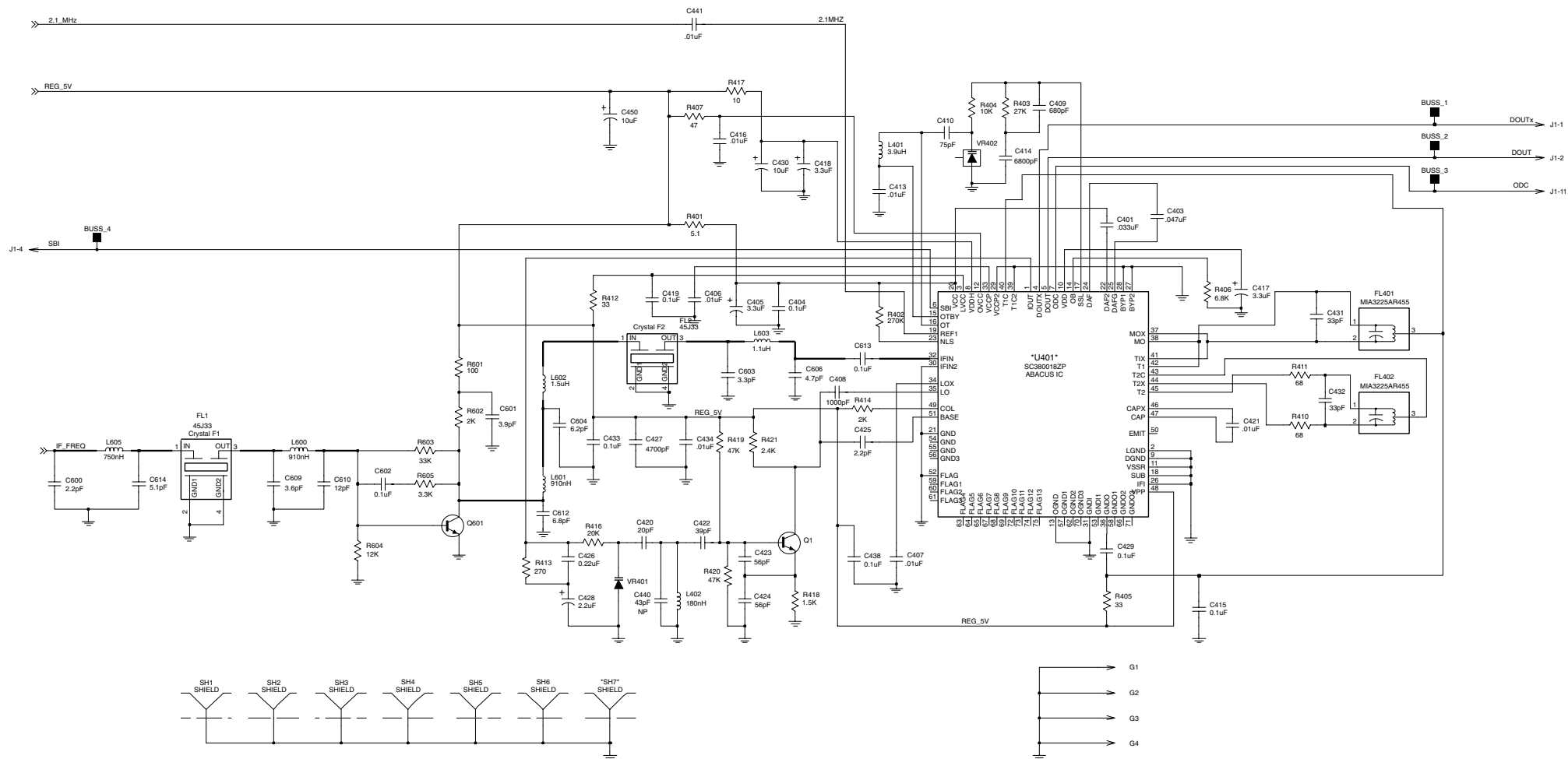


NOTE: Individual replacement parts are not available for the RF board, so the entire board must be replaced if it is defective.

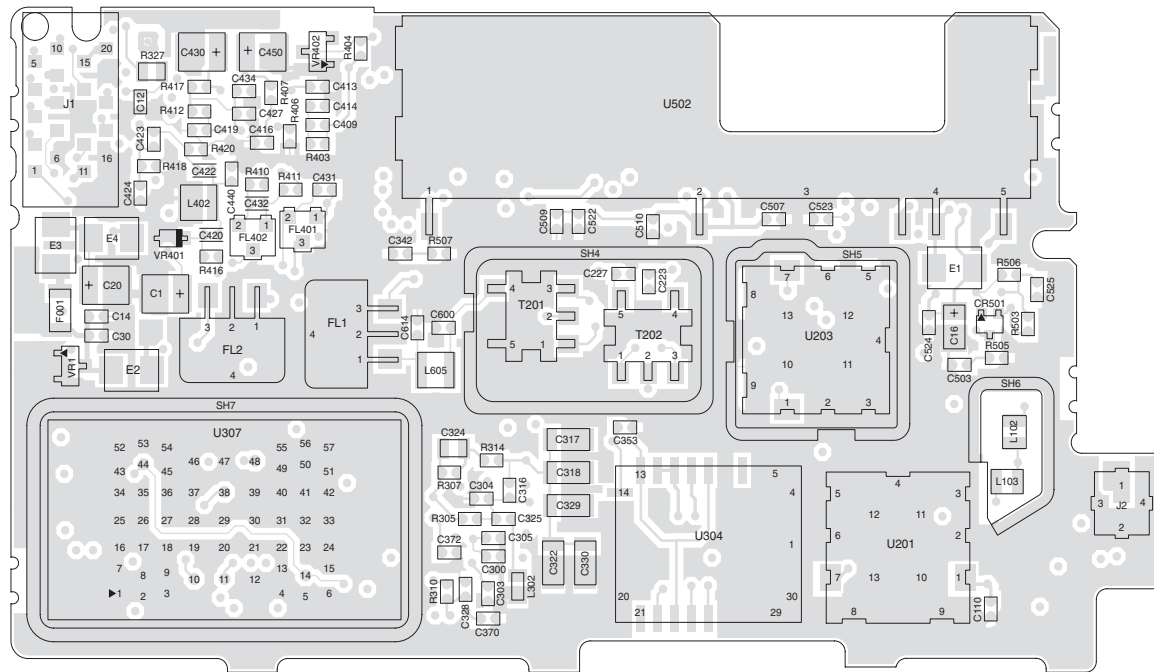
800 MHZ RF BOARD VER A/B SCHEMATIC (PAGE 1 OF 3)



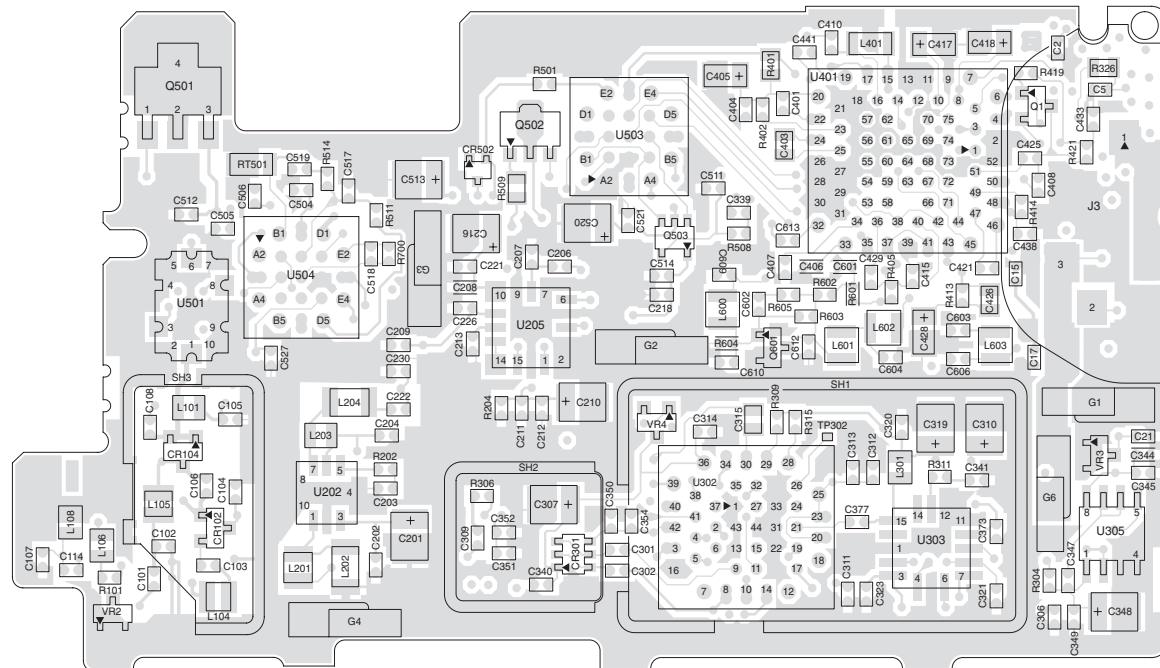
800 MHZ RF BOARD VER A/B SCHEMATIC (PAGE 2 OF 3)



800 MHZ RF BOARD VER A/B SCHEMATIC (PAGE 3 OF 3)

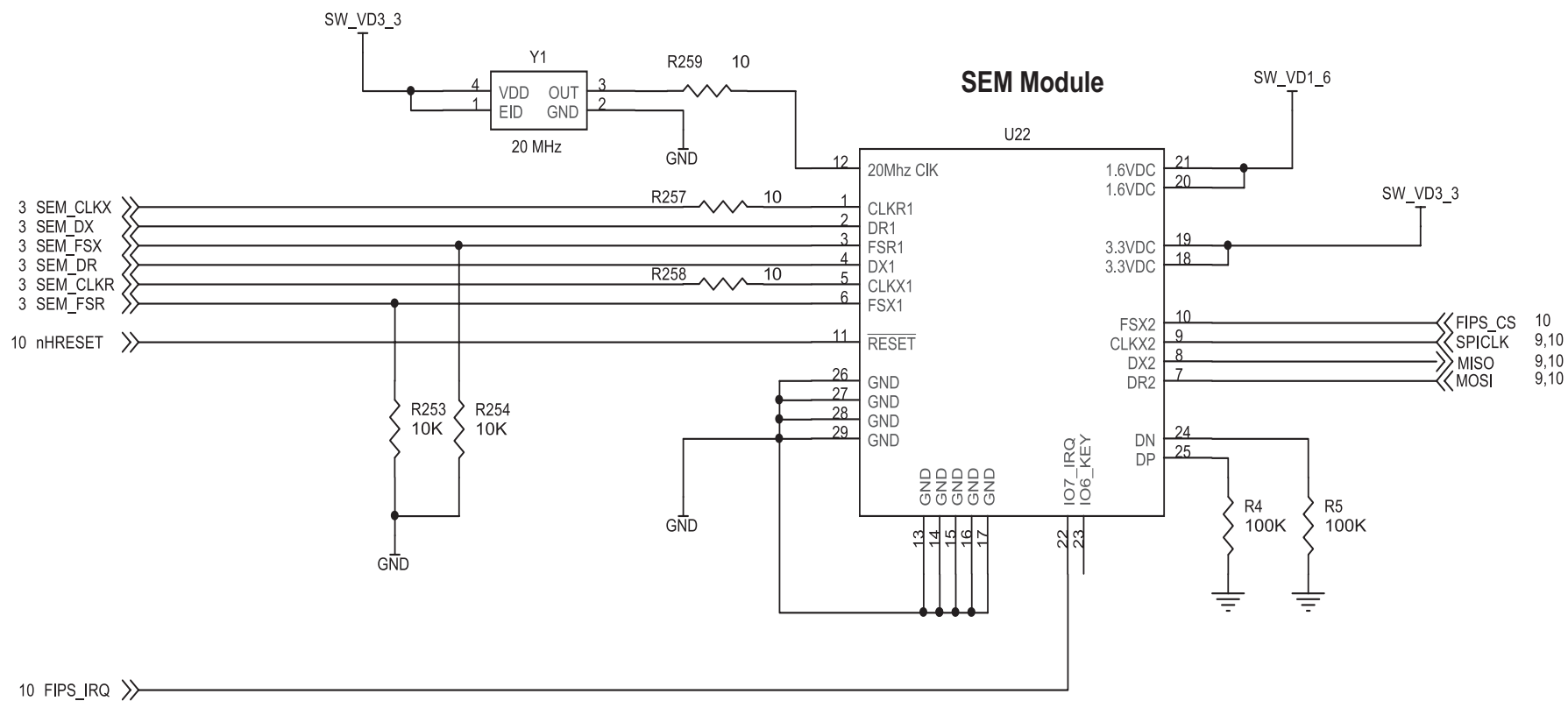


TOP VIEW

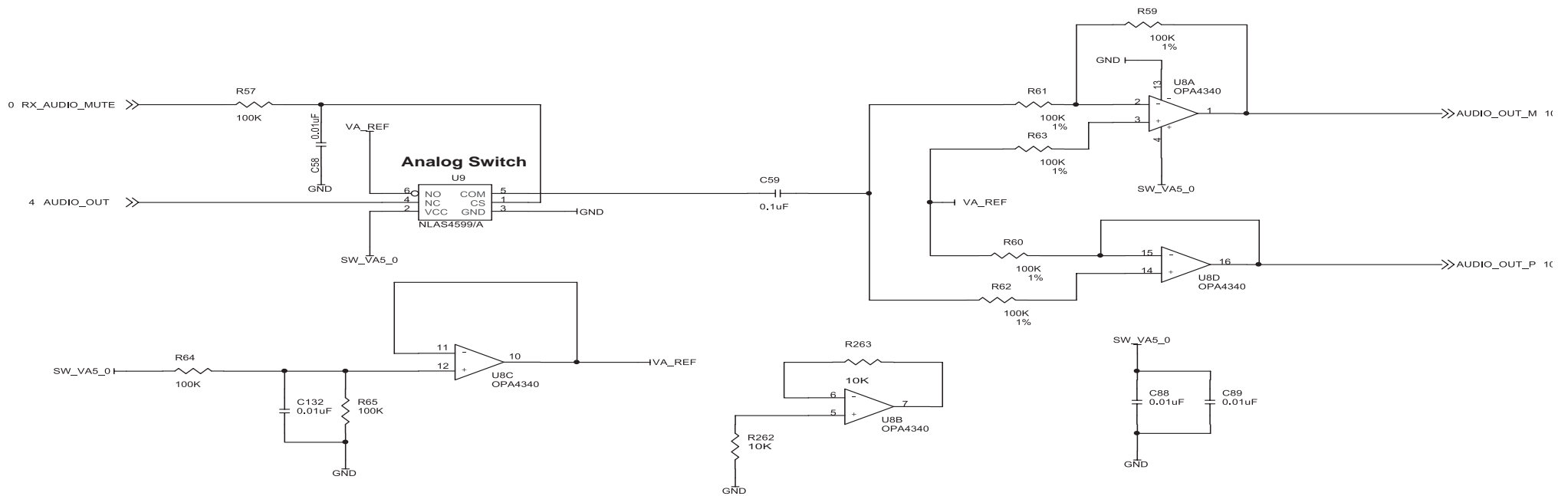


BOTTOM VIEW

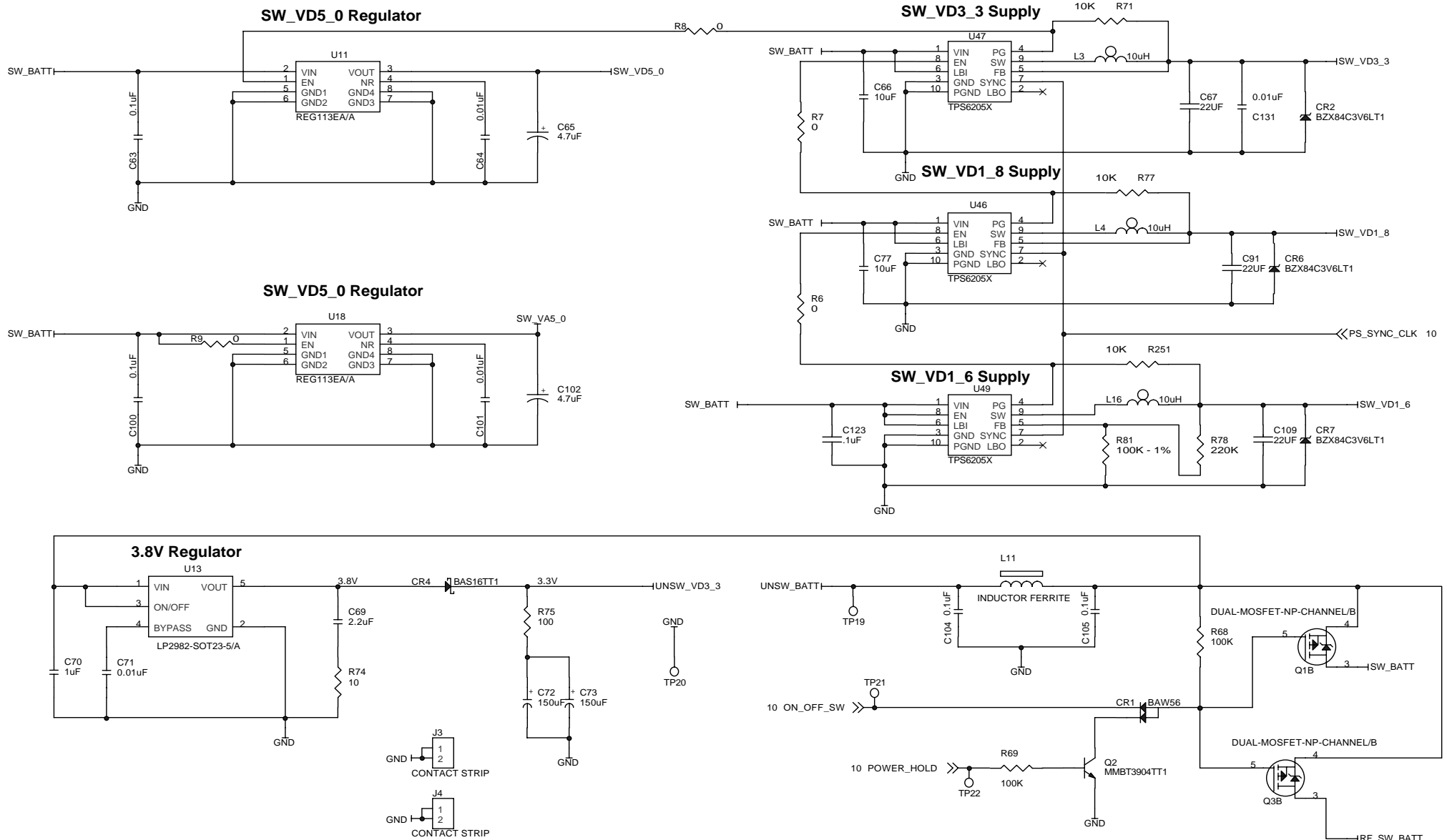




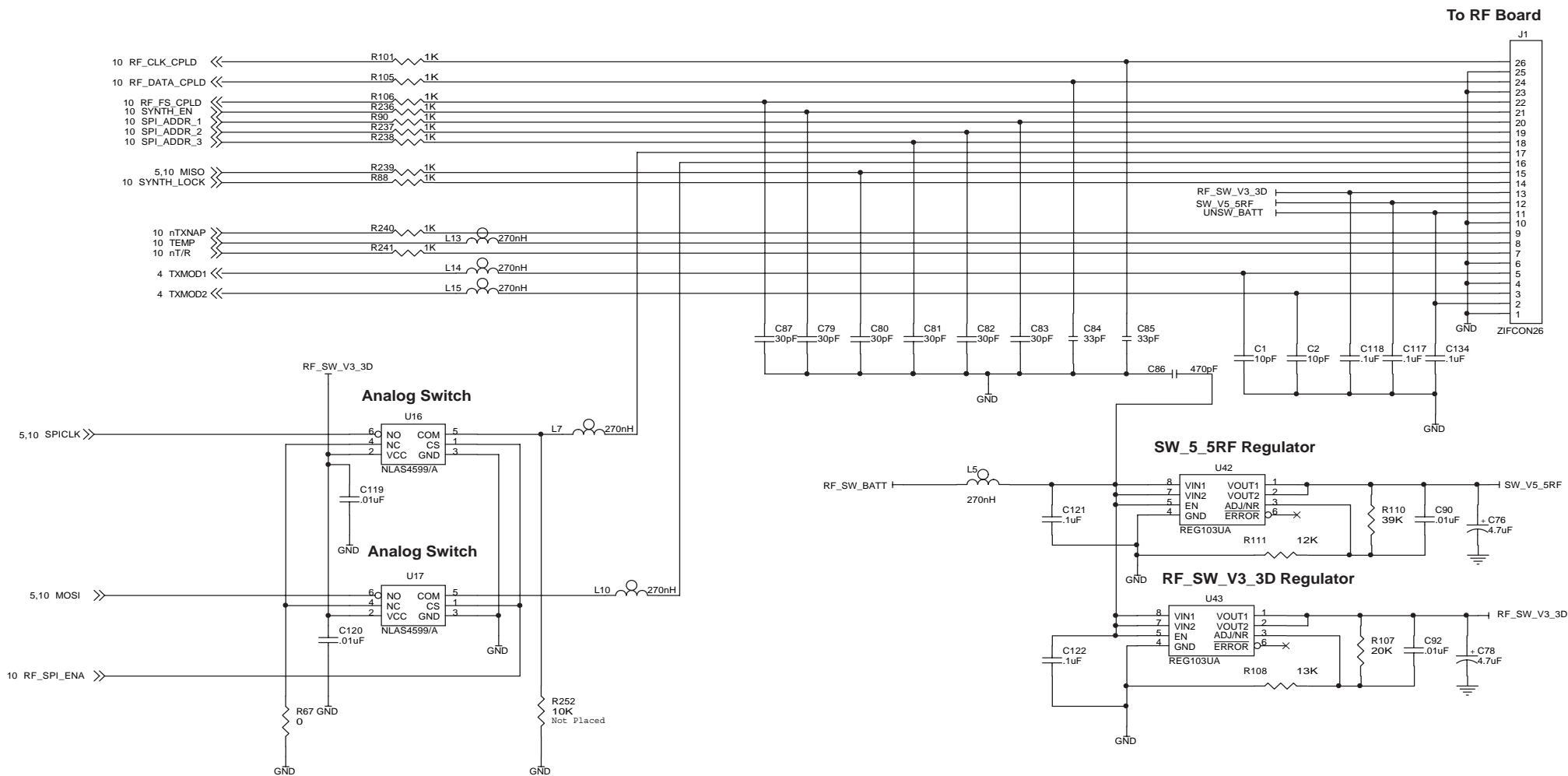
5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 5 OF 11)



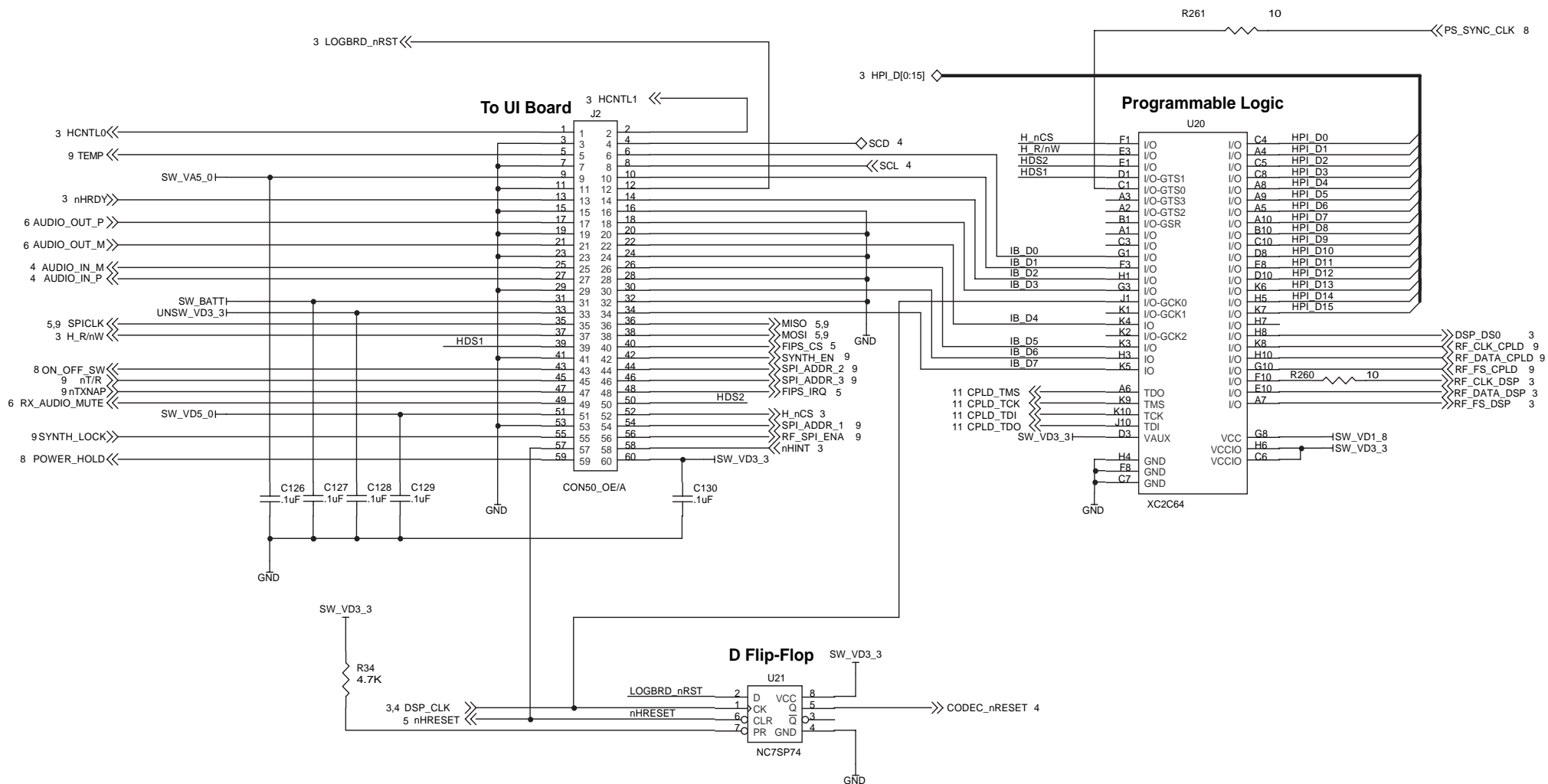
5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 6 OF 11)



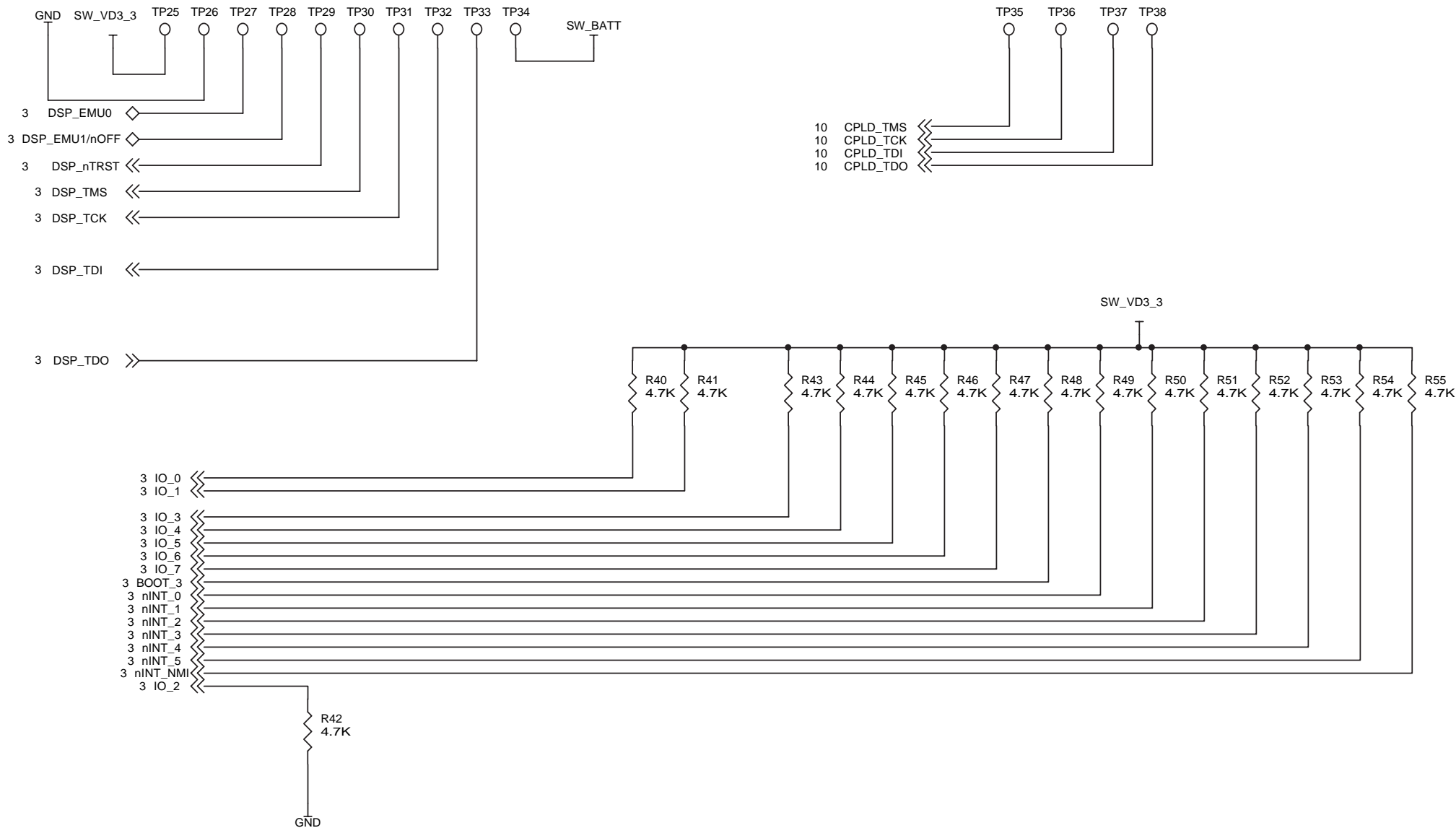
5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 8 OF 11)



5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 9 OF 11)



5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 10 OF 11)

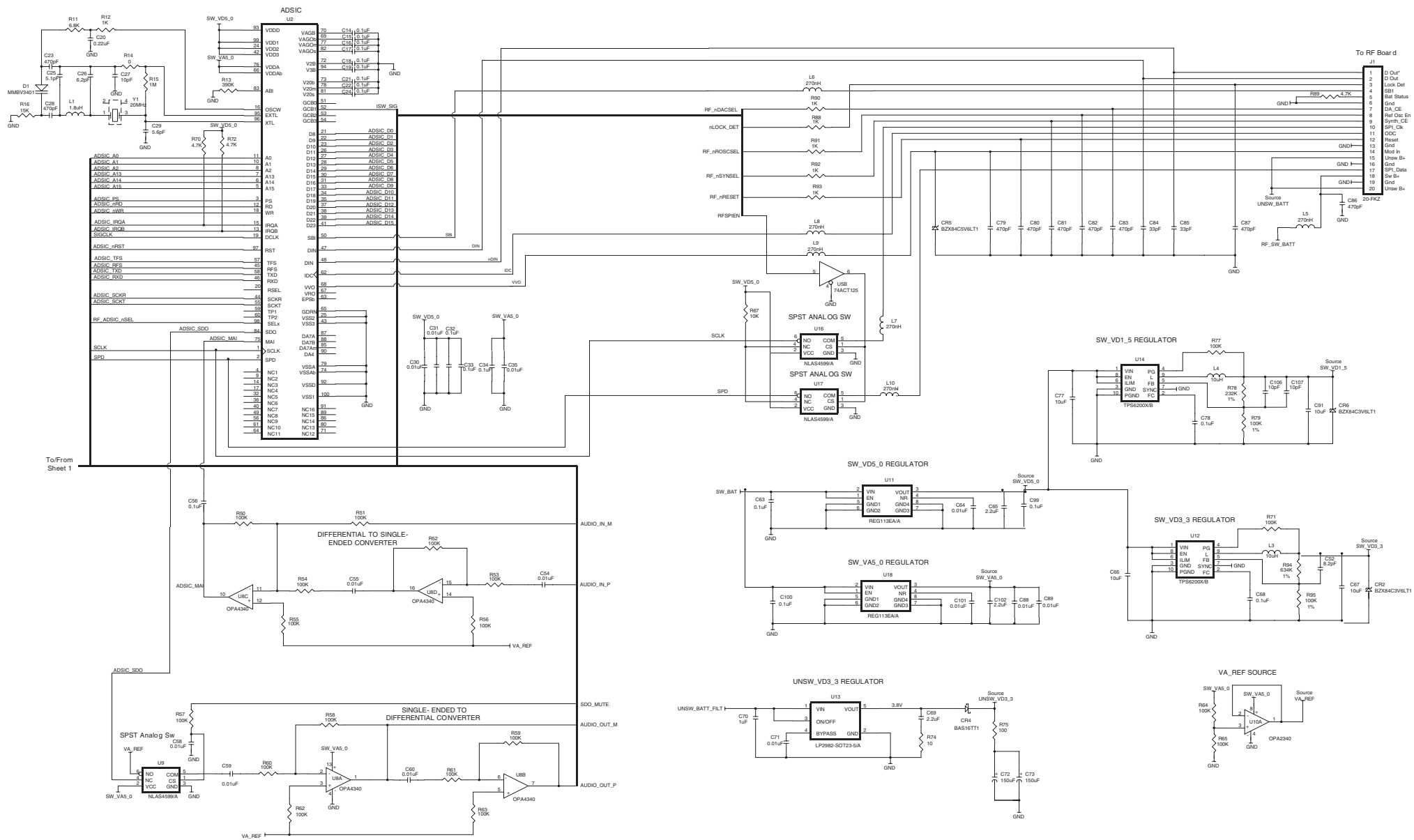


5500-120 LOGIC BOARD VER C SCHEMATIC (PAGE 11 OF 11)

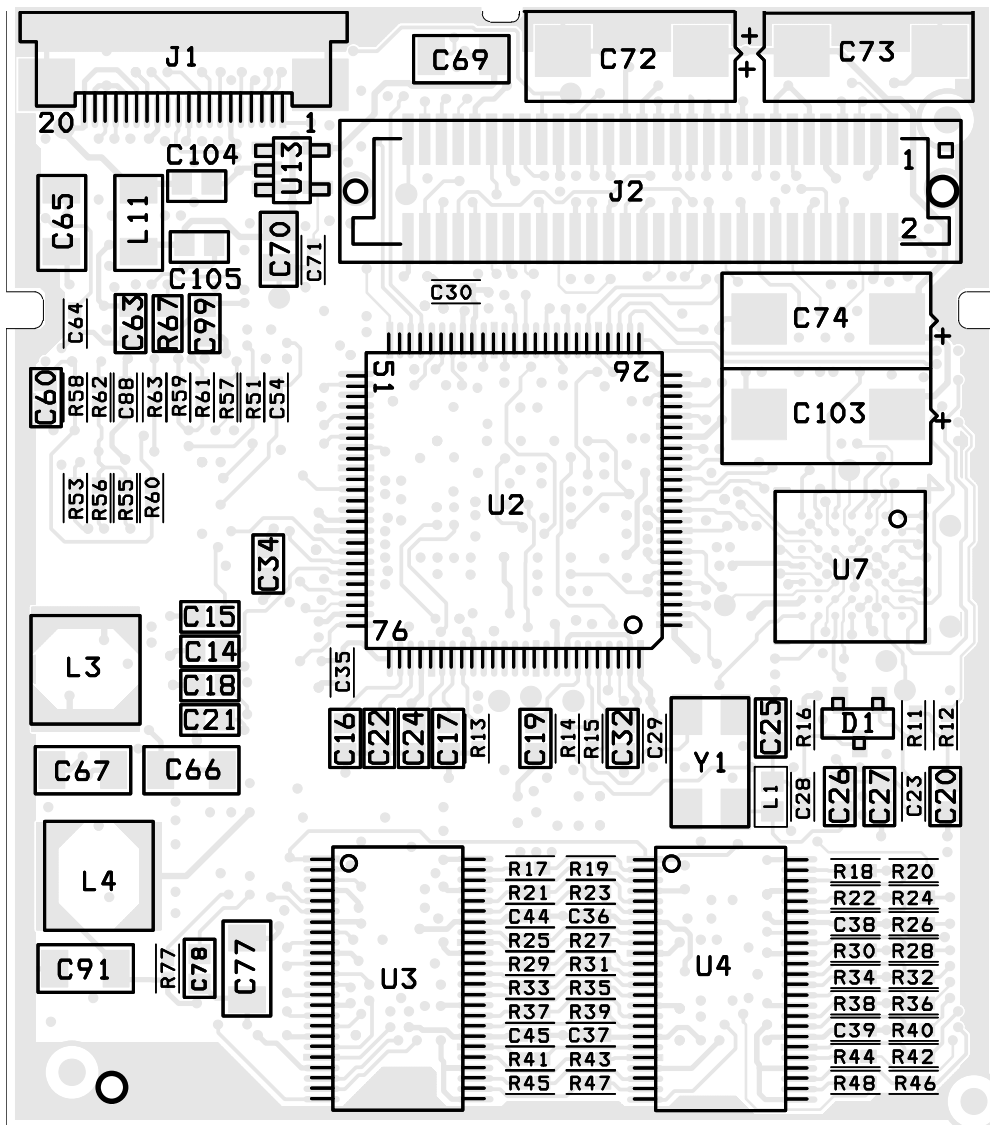


5500-120 LOGIC BOARD VER C LAYOUT

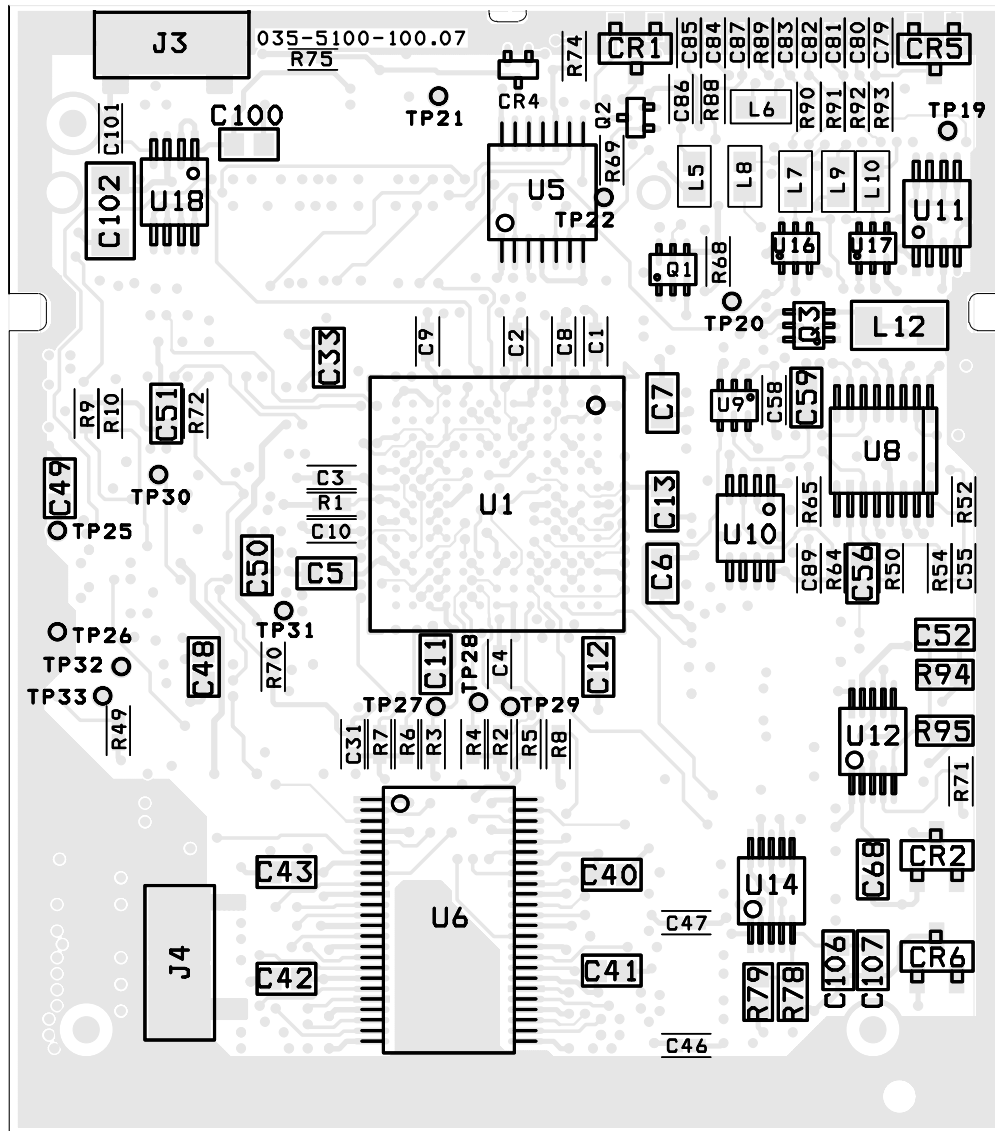




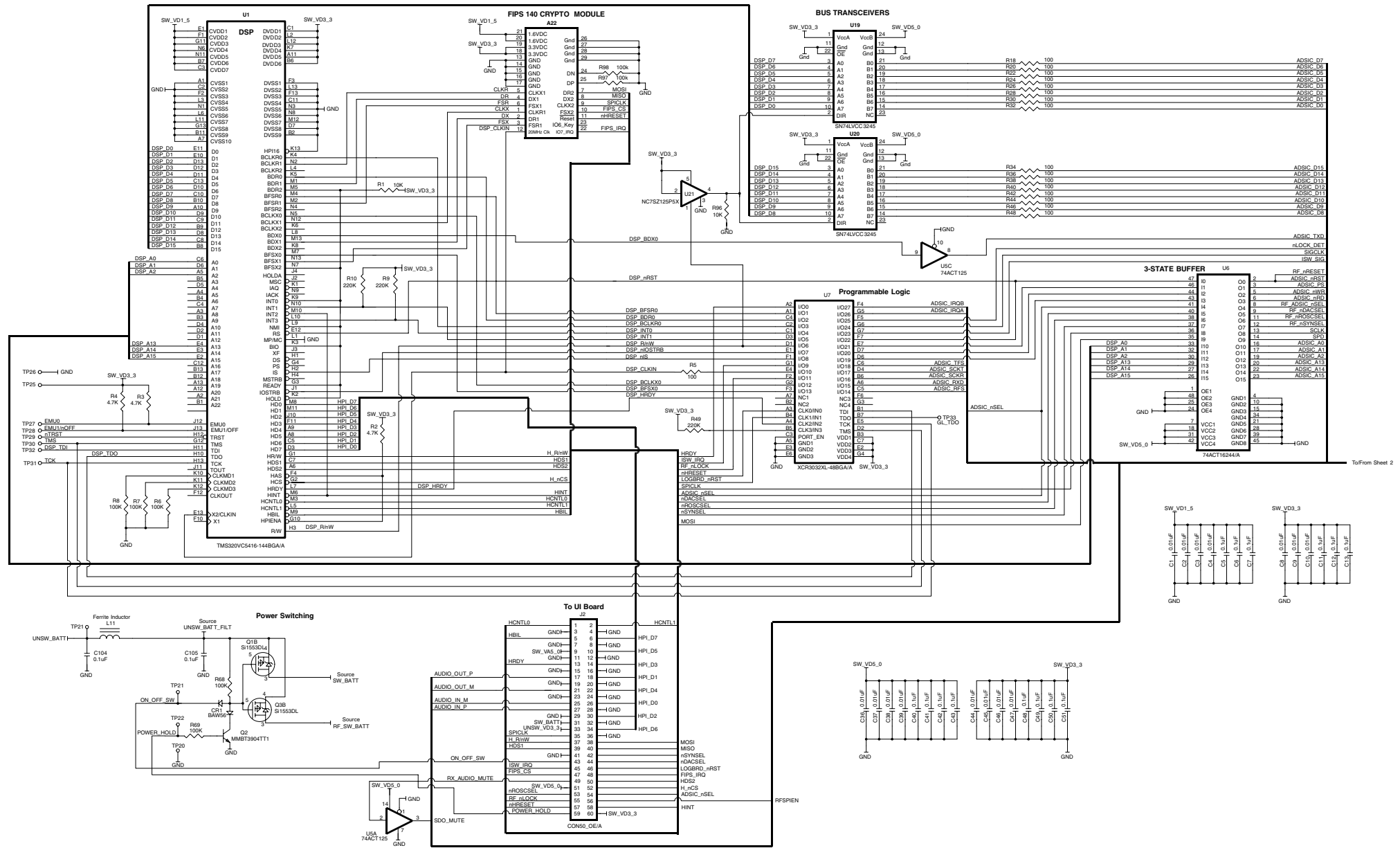
5100-110 LOGIC BOARD VER A SCHEMATIC (PAGE 2 OF 2)



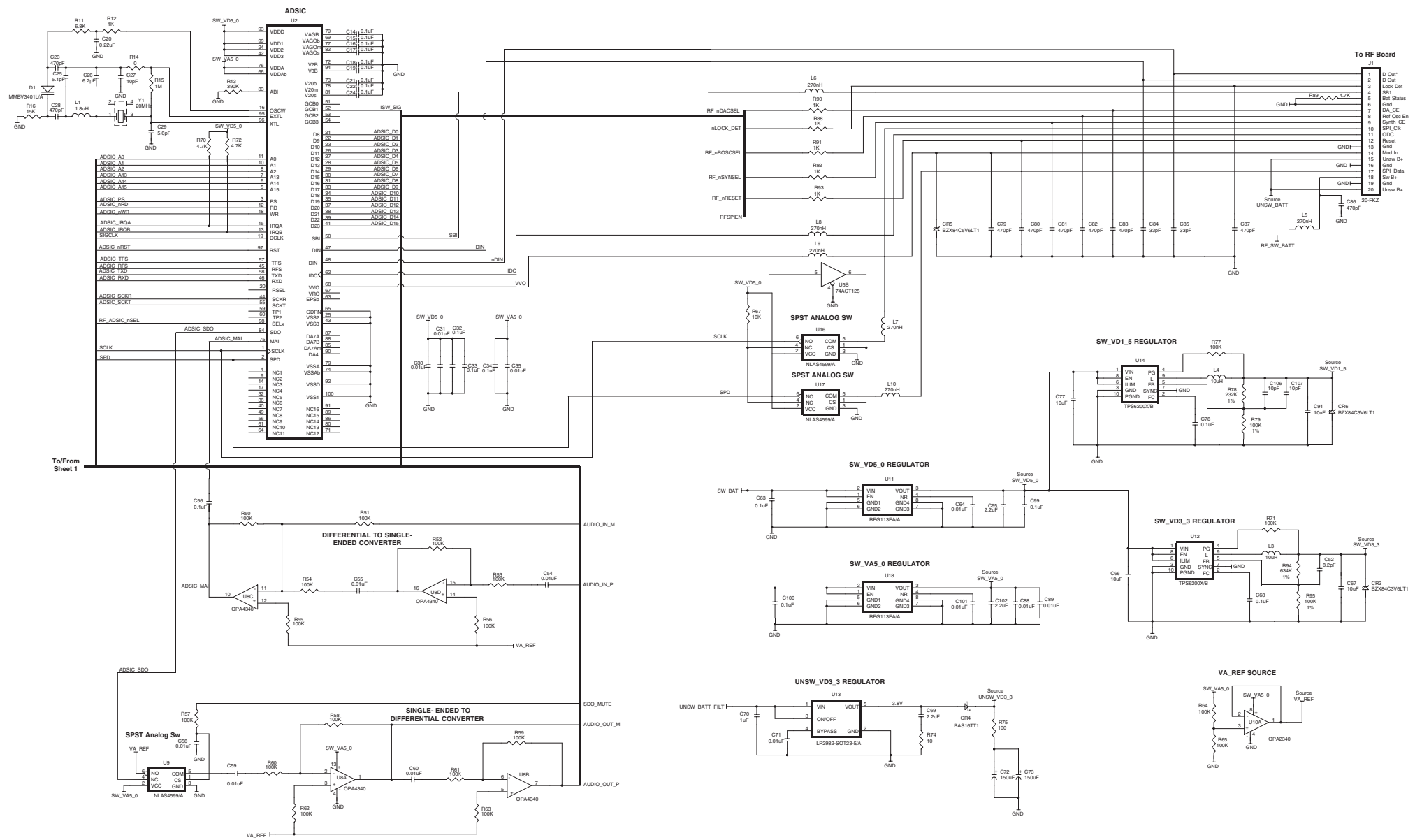
5100-110 LOGIC BOARD VER A TOP VIEW



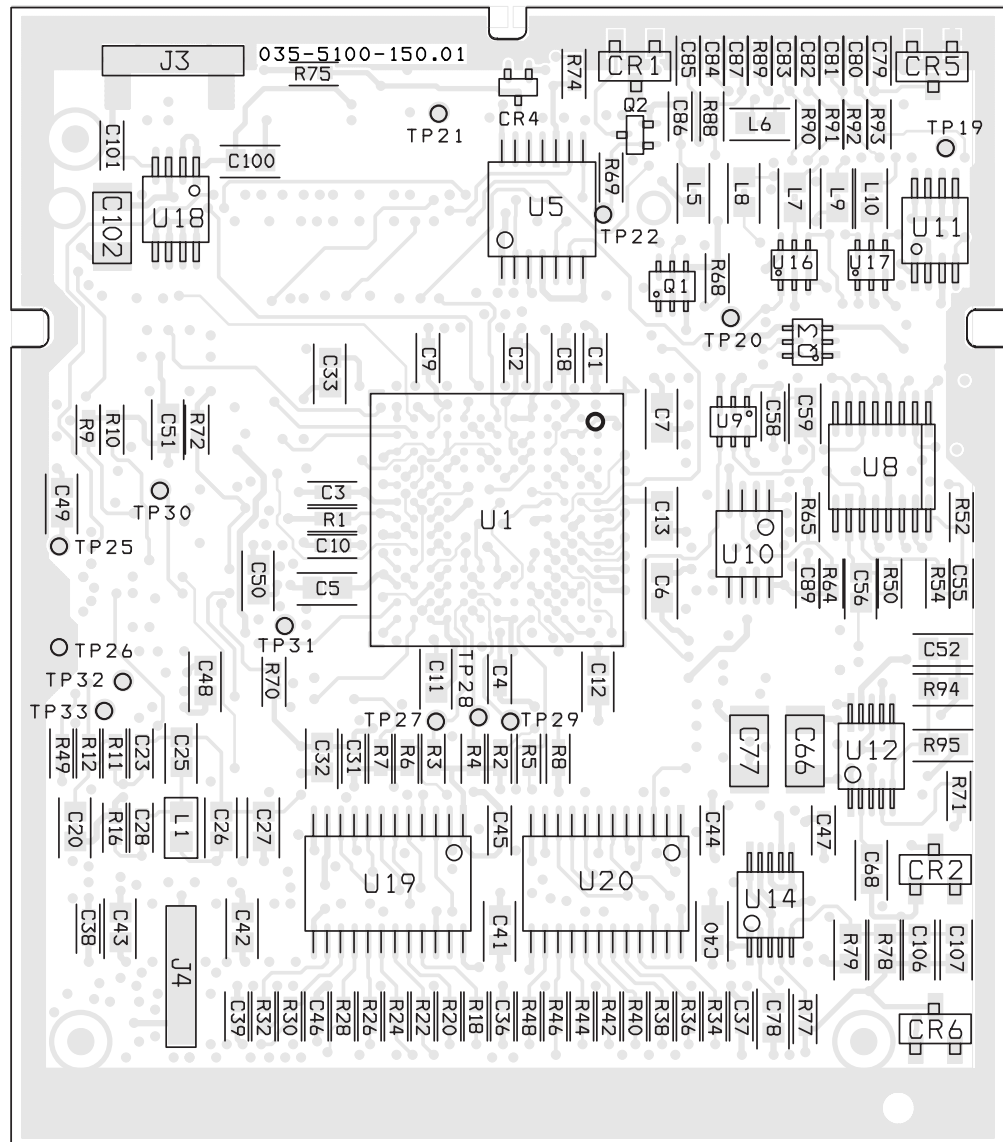
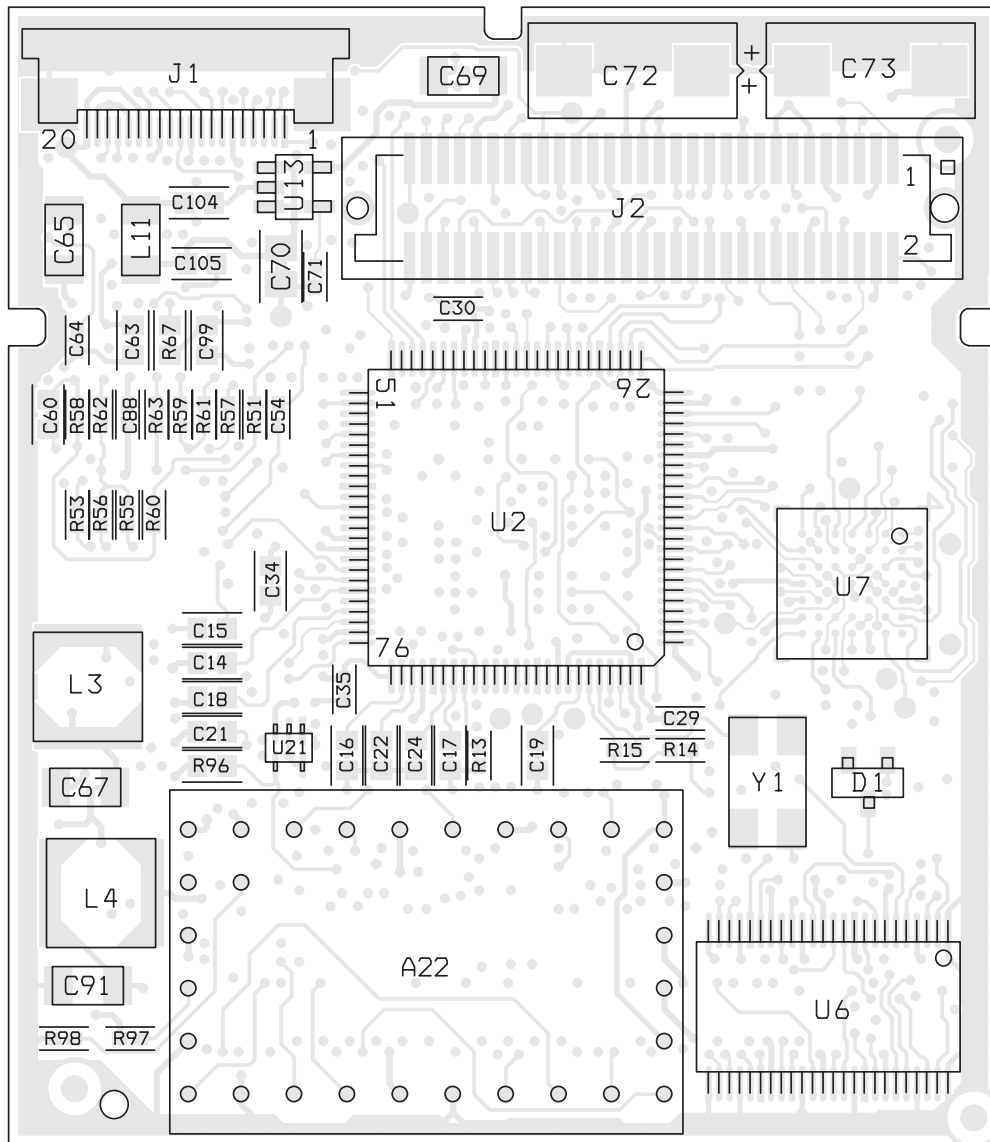
5100-110 LOGIC BOARD VER A BOTTOM VIEW

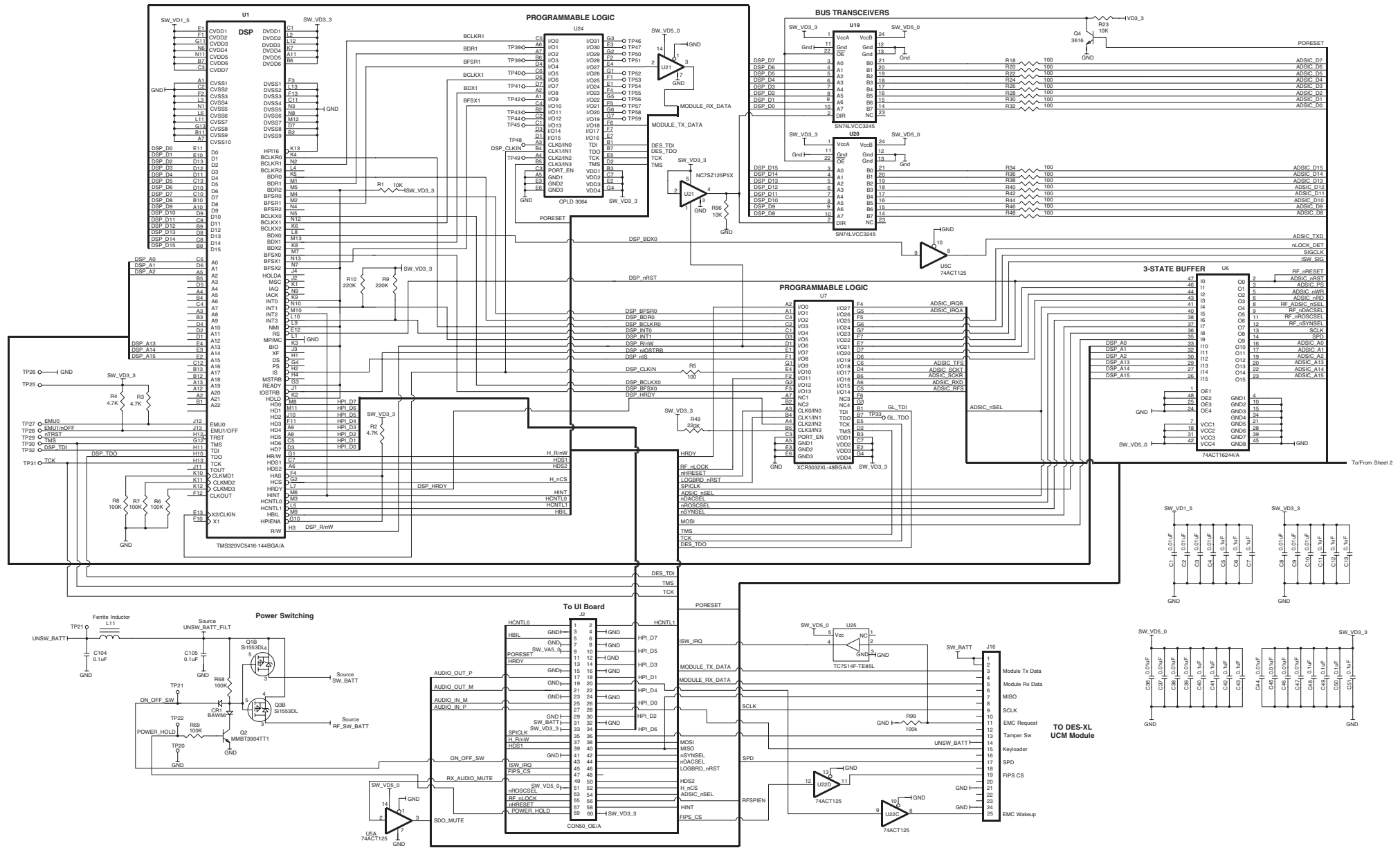


5100-150 LOGIC BOARD VER B SCHEMATIC (PAGE 1 OF 2)



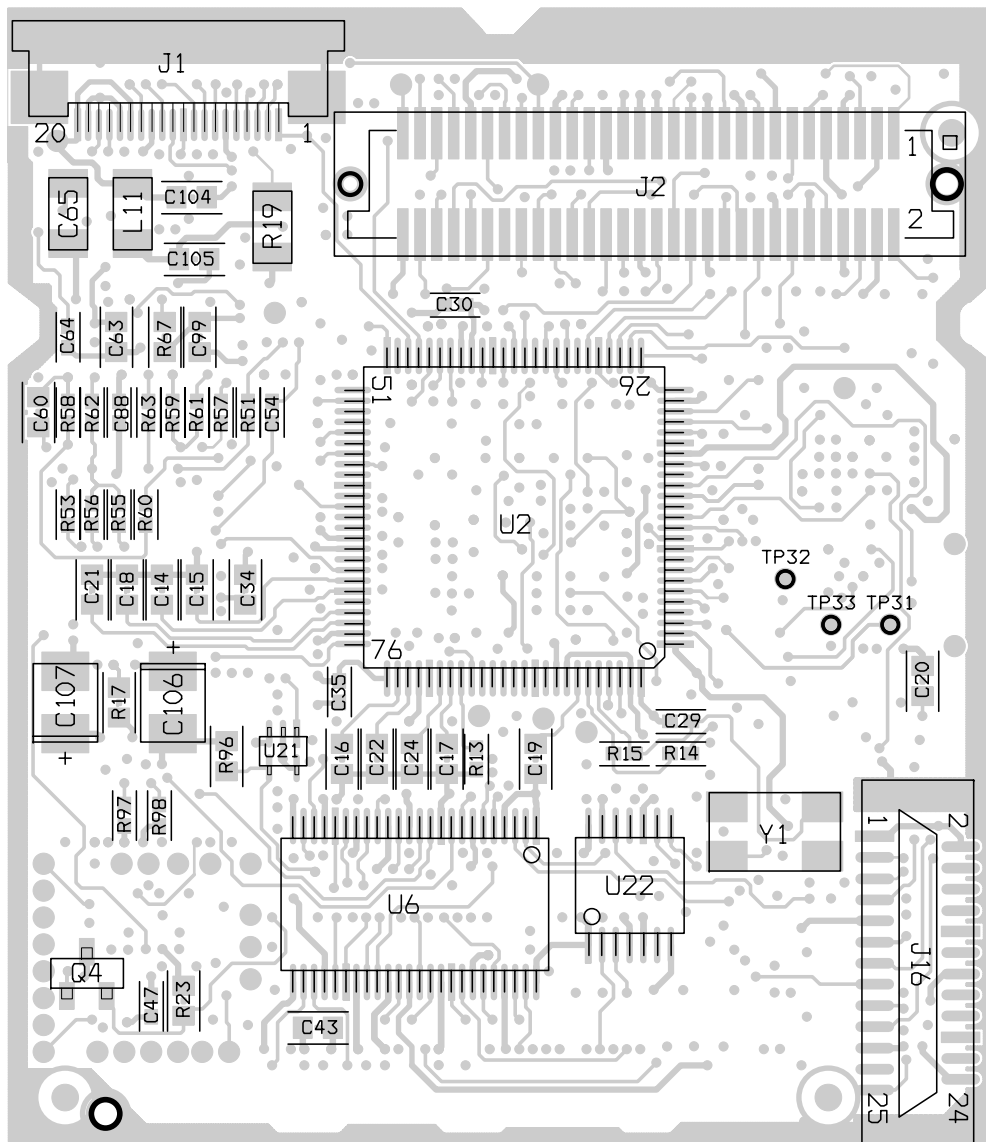
5100-150 LOGIC BOARD VER B SCHEMATIC (PAGE 2 OF 2)



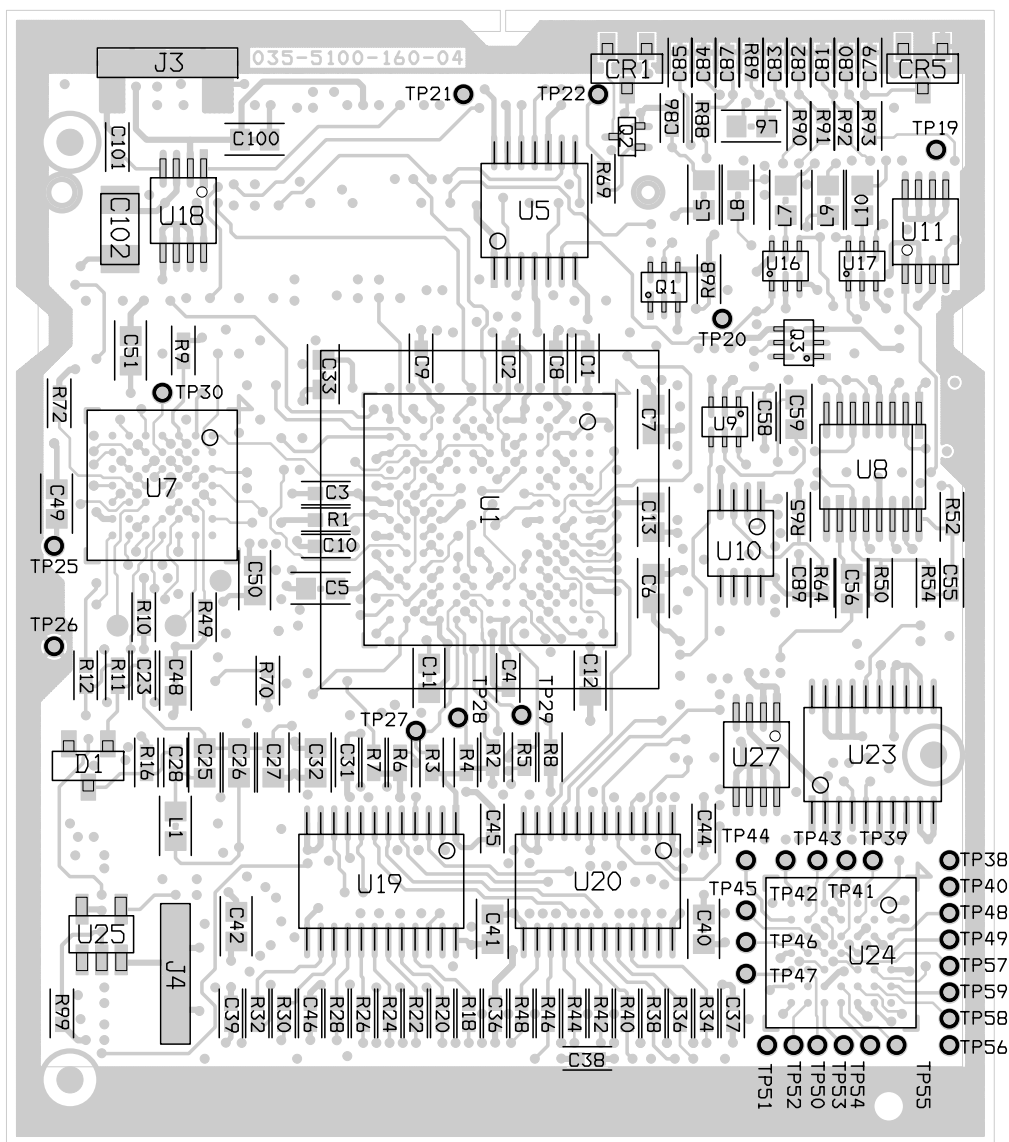


5100-160 LOGIC BOARD VER B SCHEMATIC (PAGE 1 OF 2)

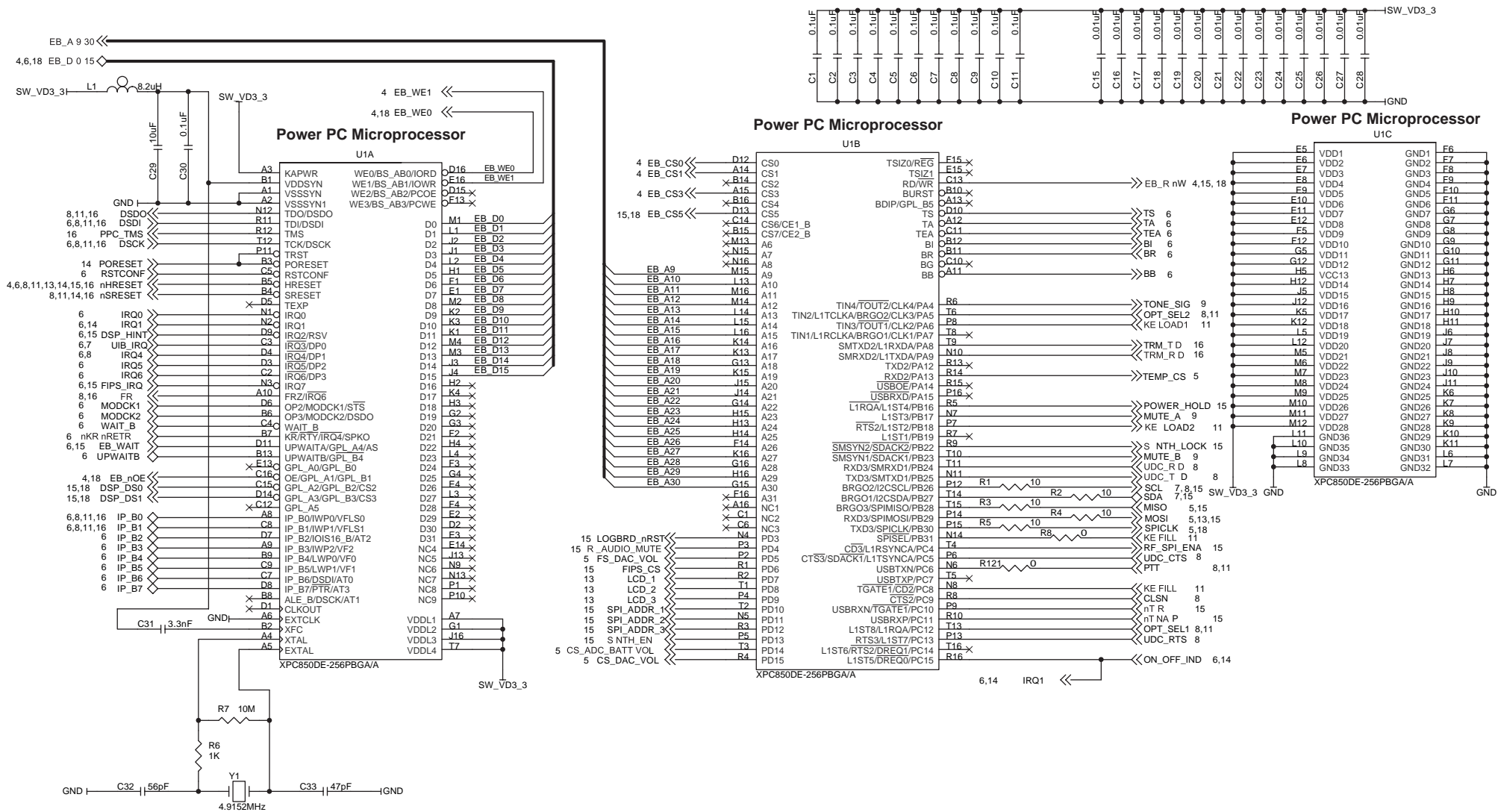




5100-160 LOGIC BOARD VER B TOP VIEW

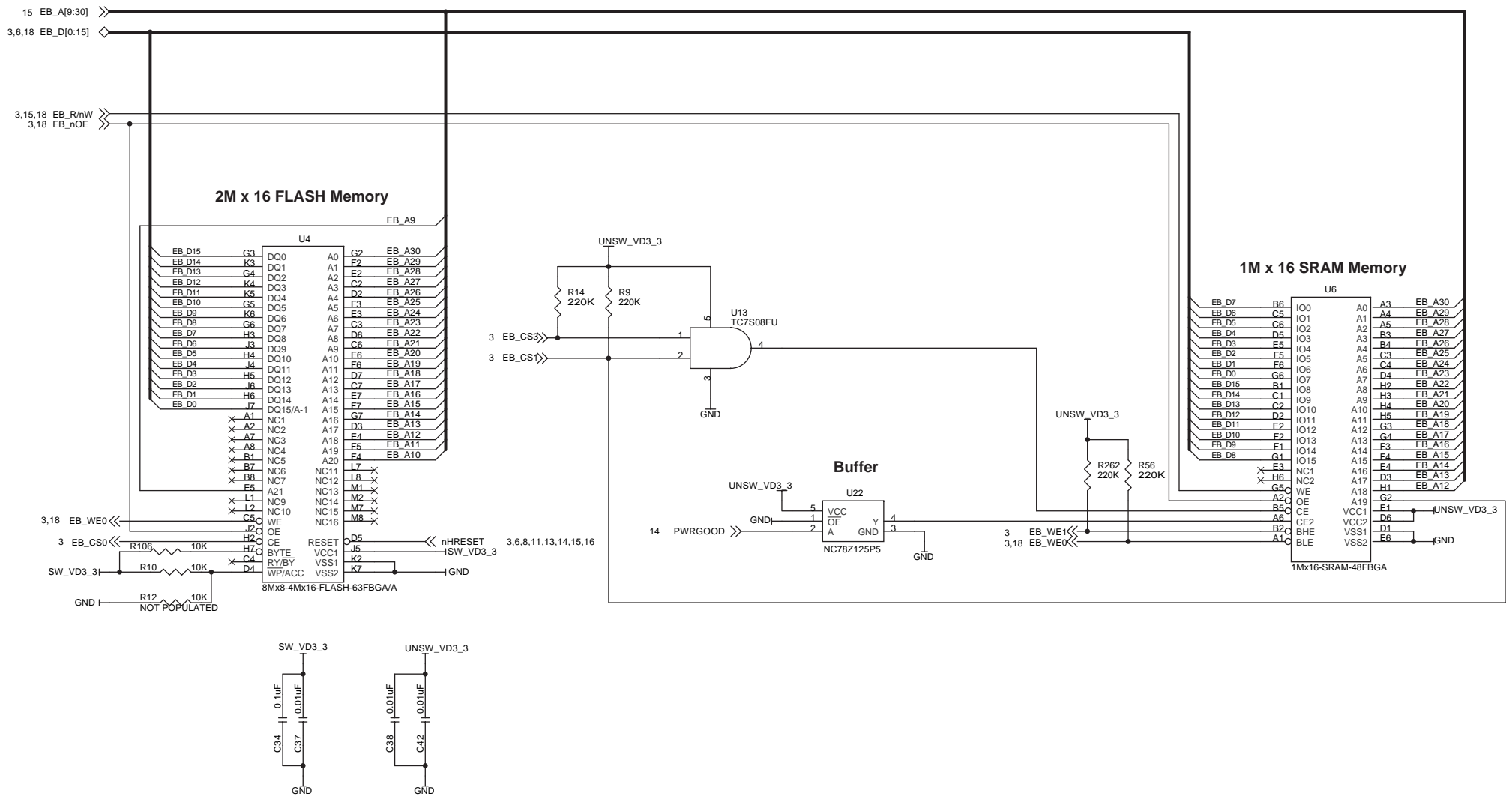


5100-160 LOGIC BOARD VER B BOTTOM VIEW

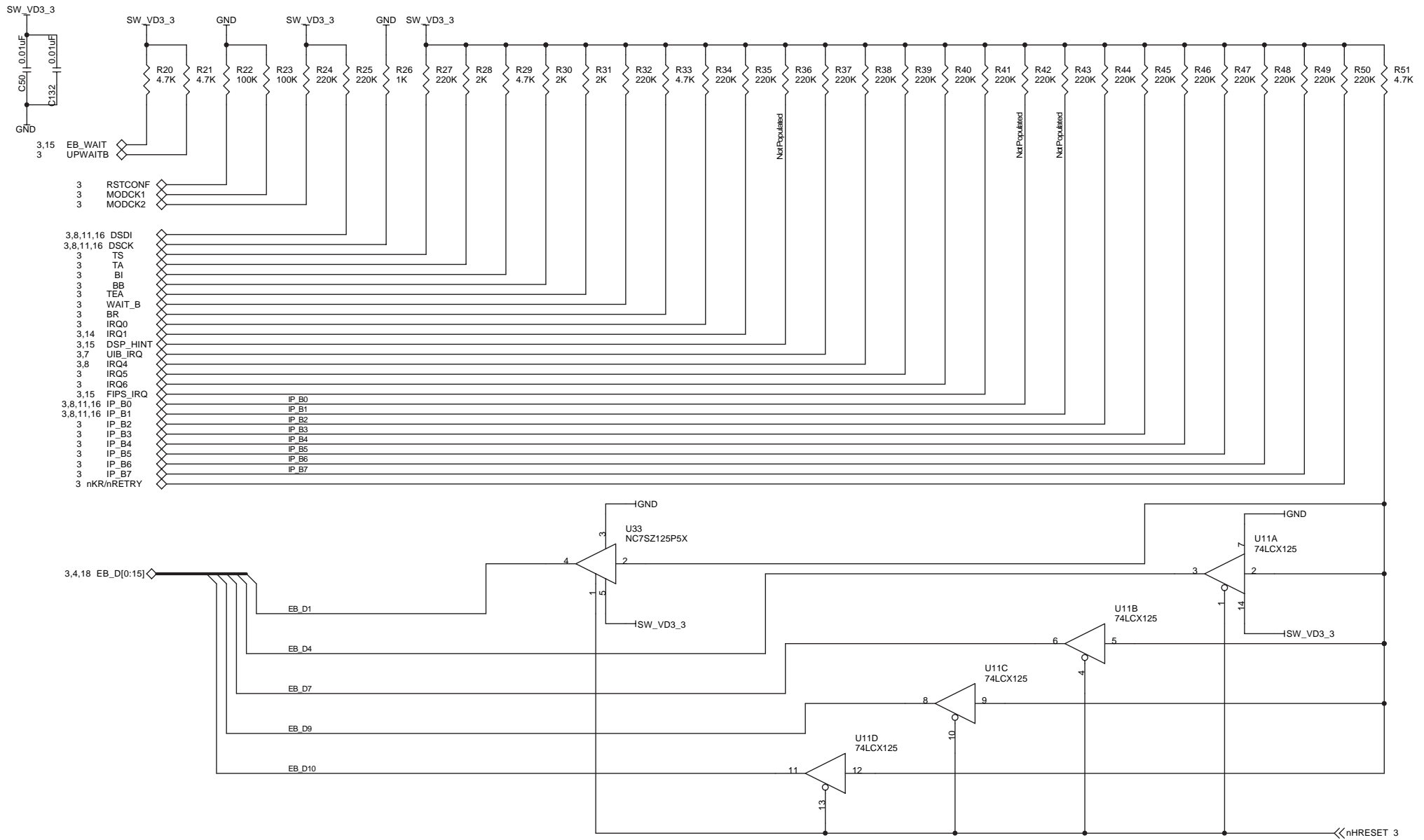


NOTE: The number from 3-18 next to a node label indicates the page number of the circuit to which it connects.

5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 3 OF 18)

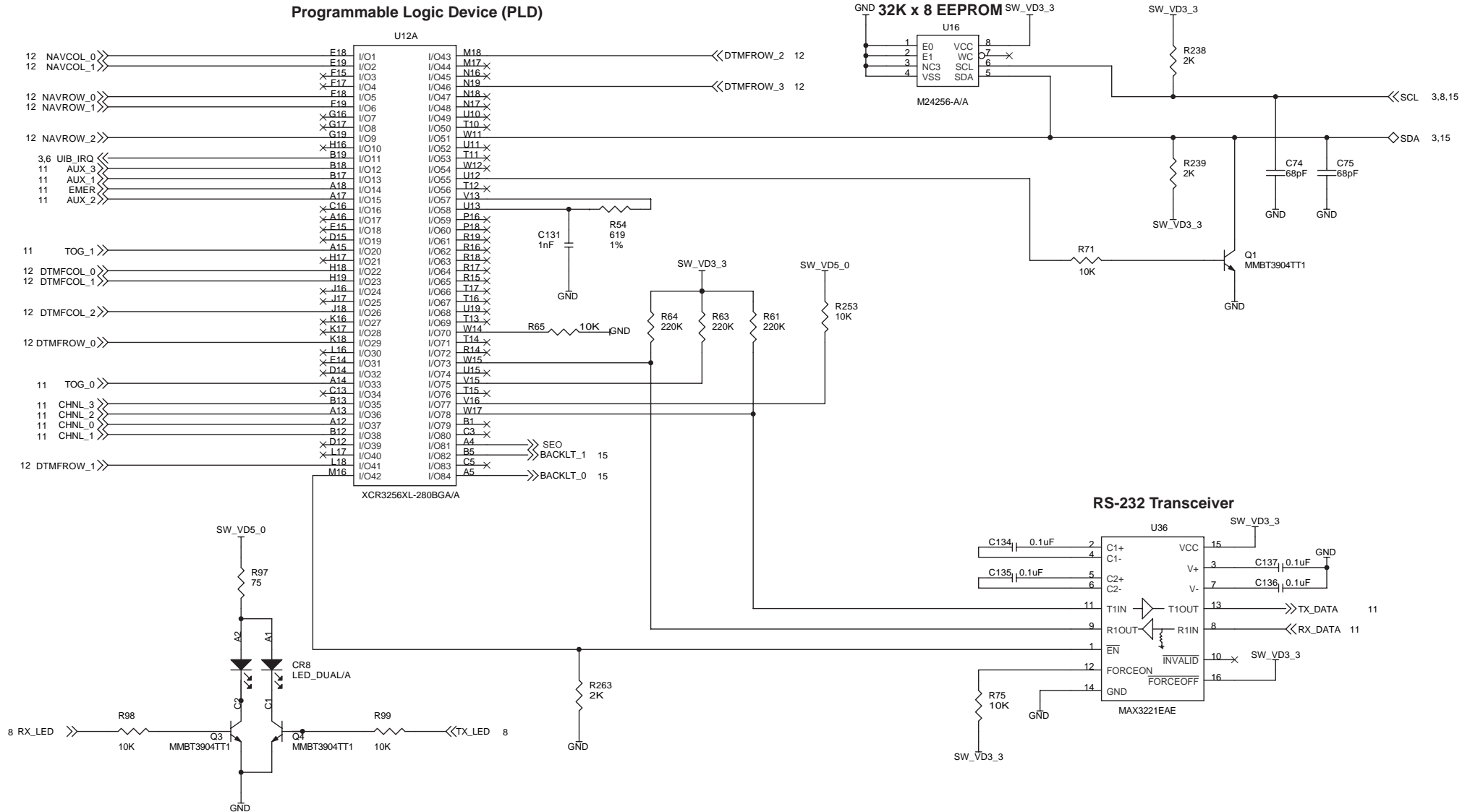


5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 4 OF 18)

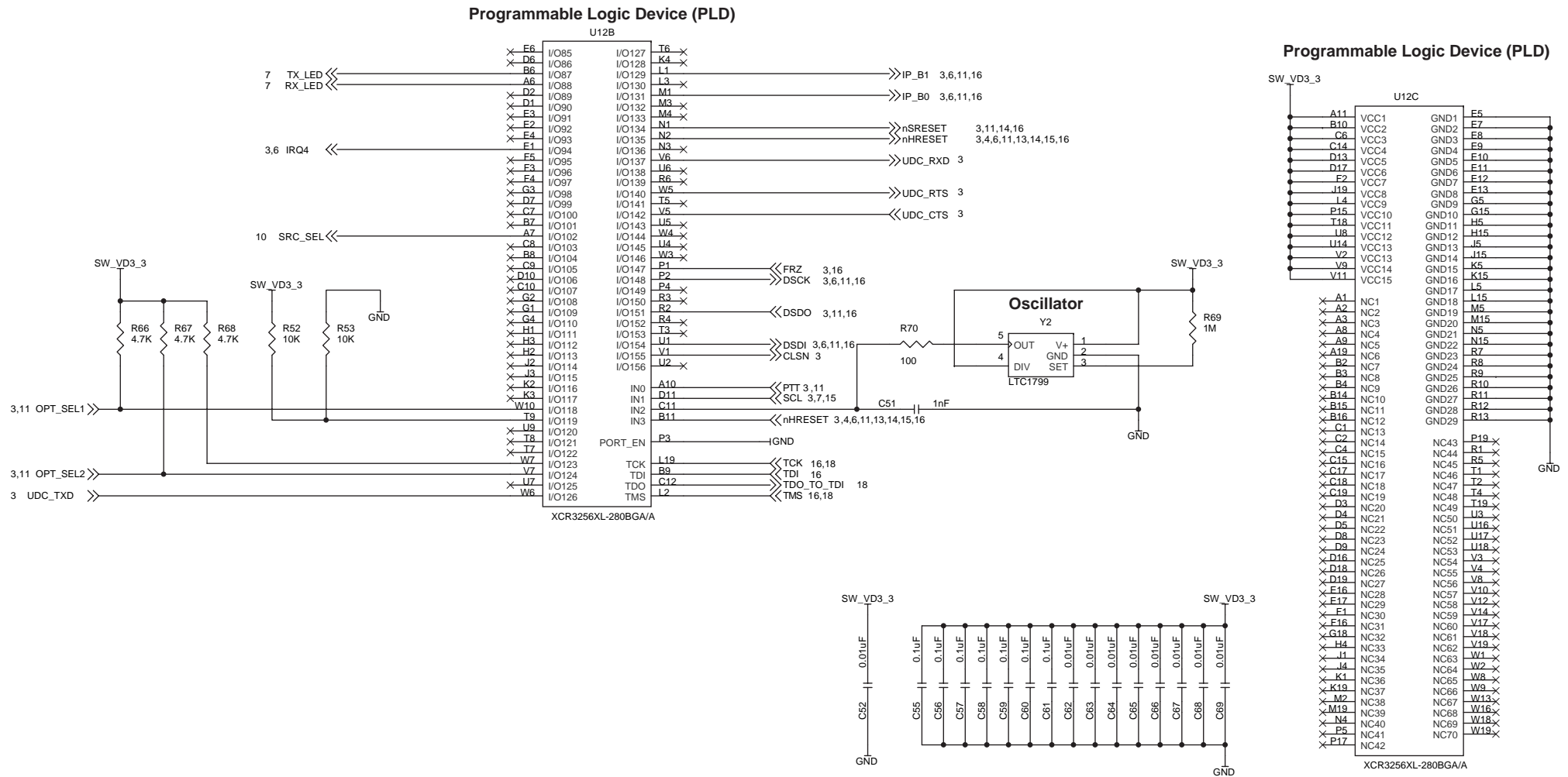


5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 6 OF 18)

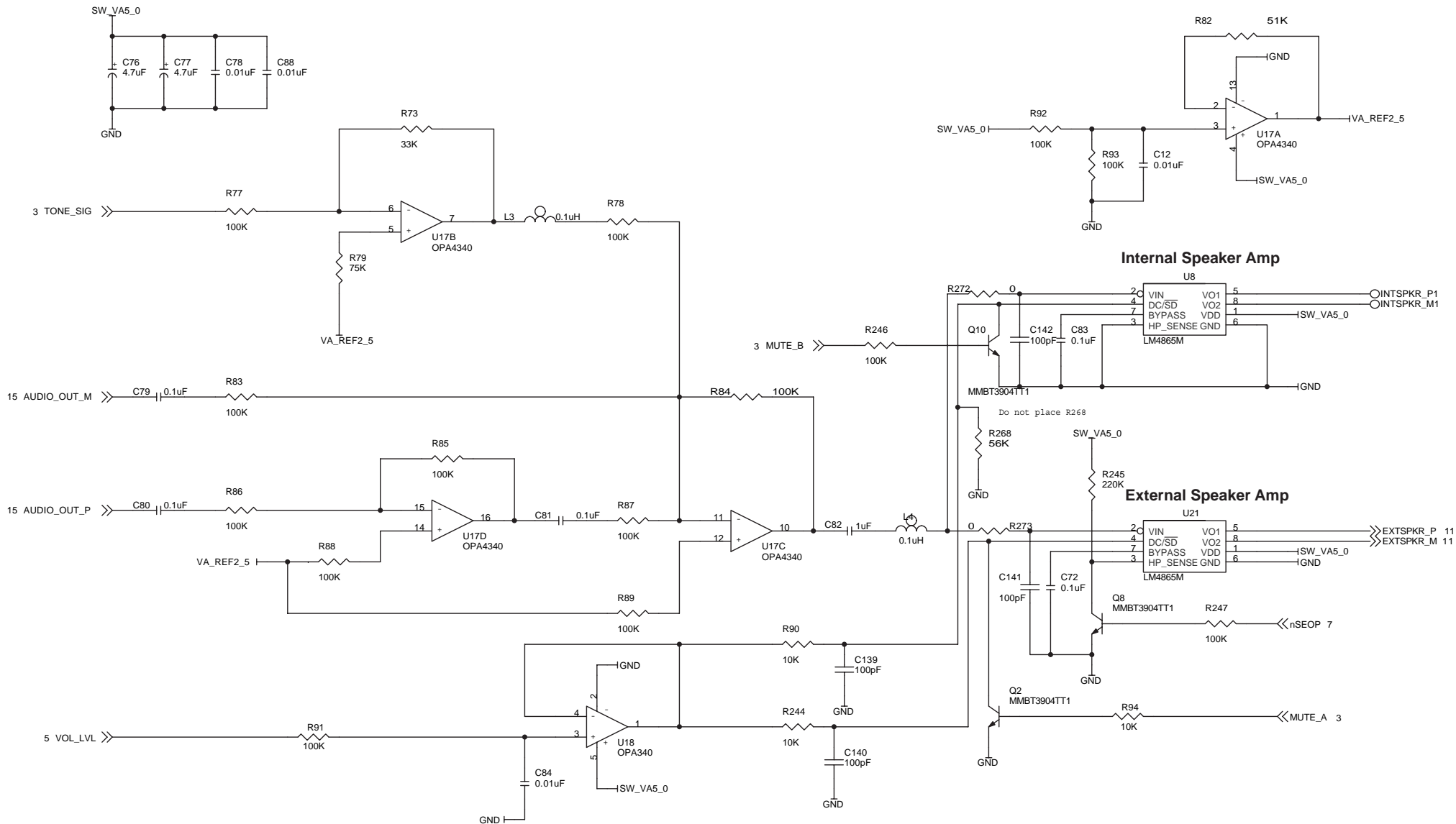
Programmable Logic Device (PLD)



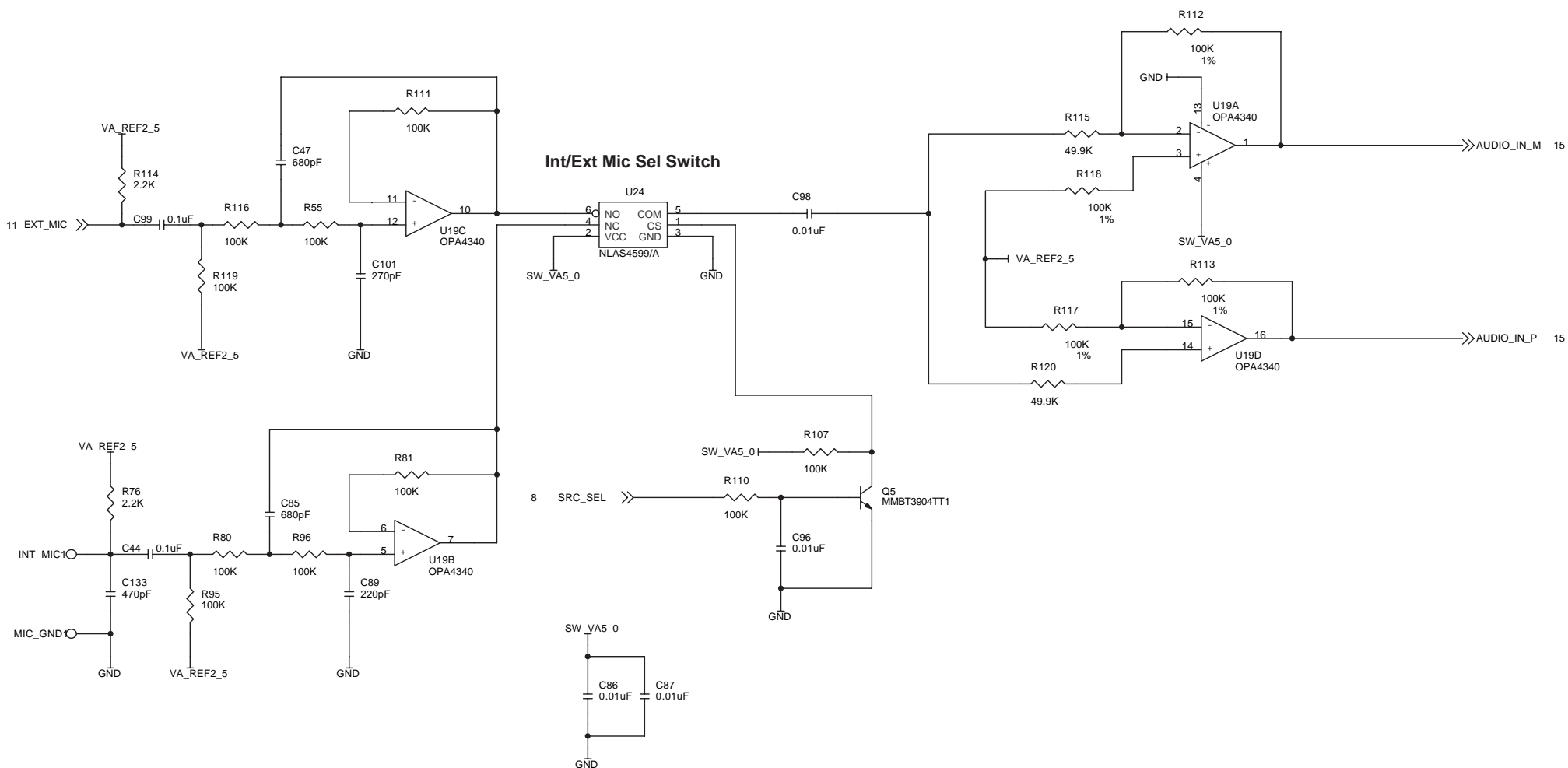
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 7 OF 18)



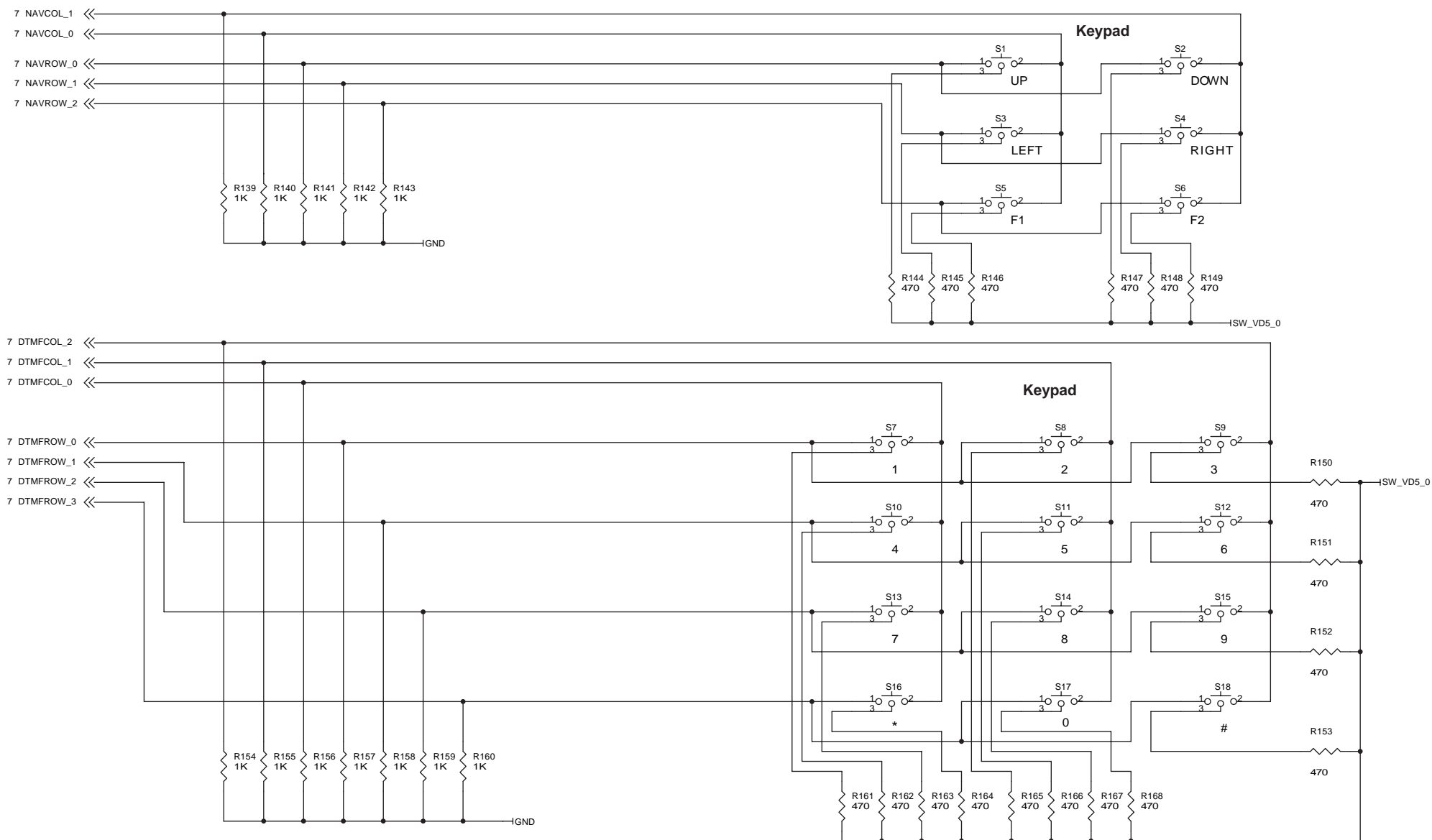
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 8 OF 18)



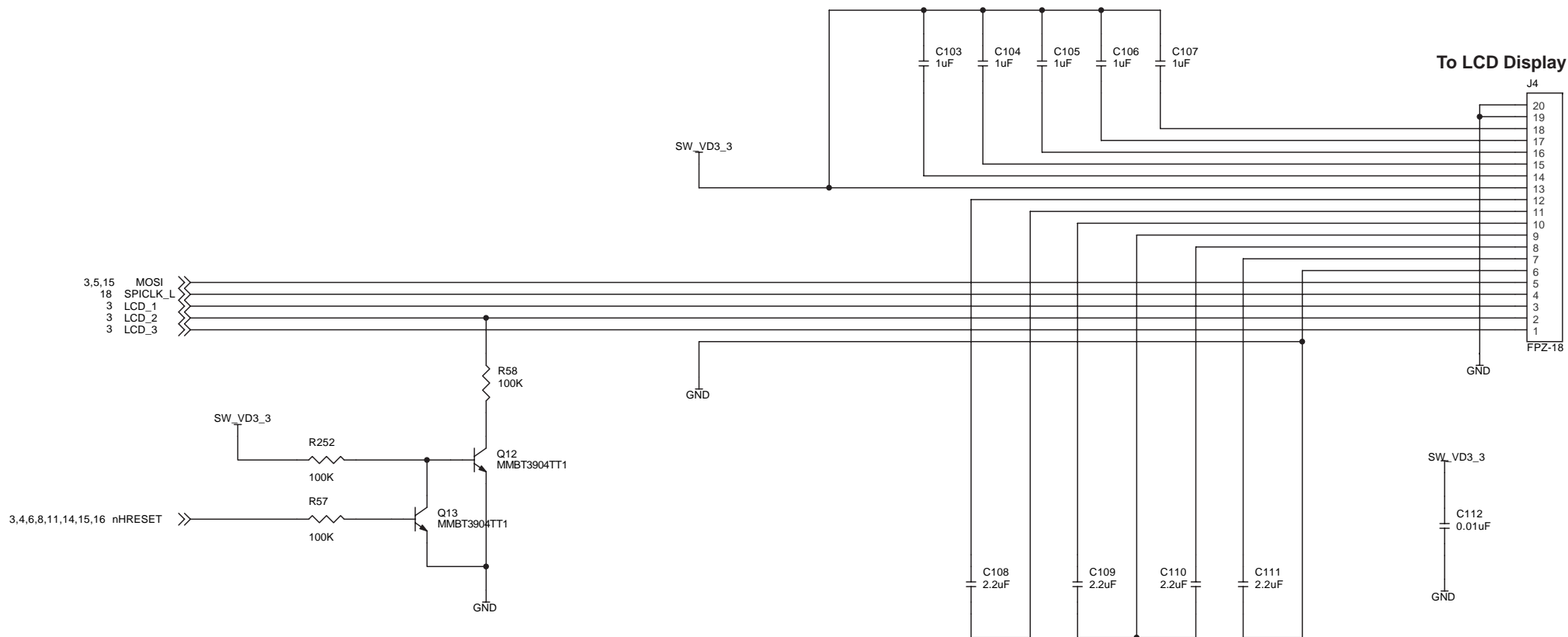
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 9 OF 18)



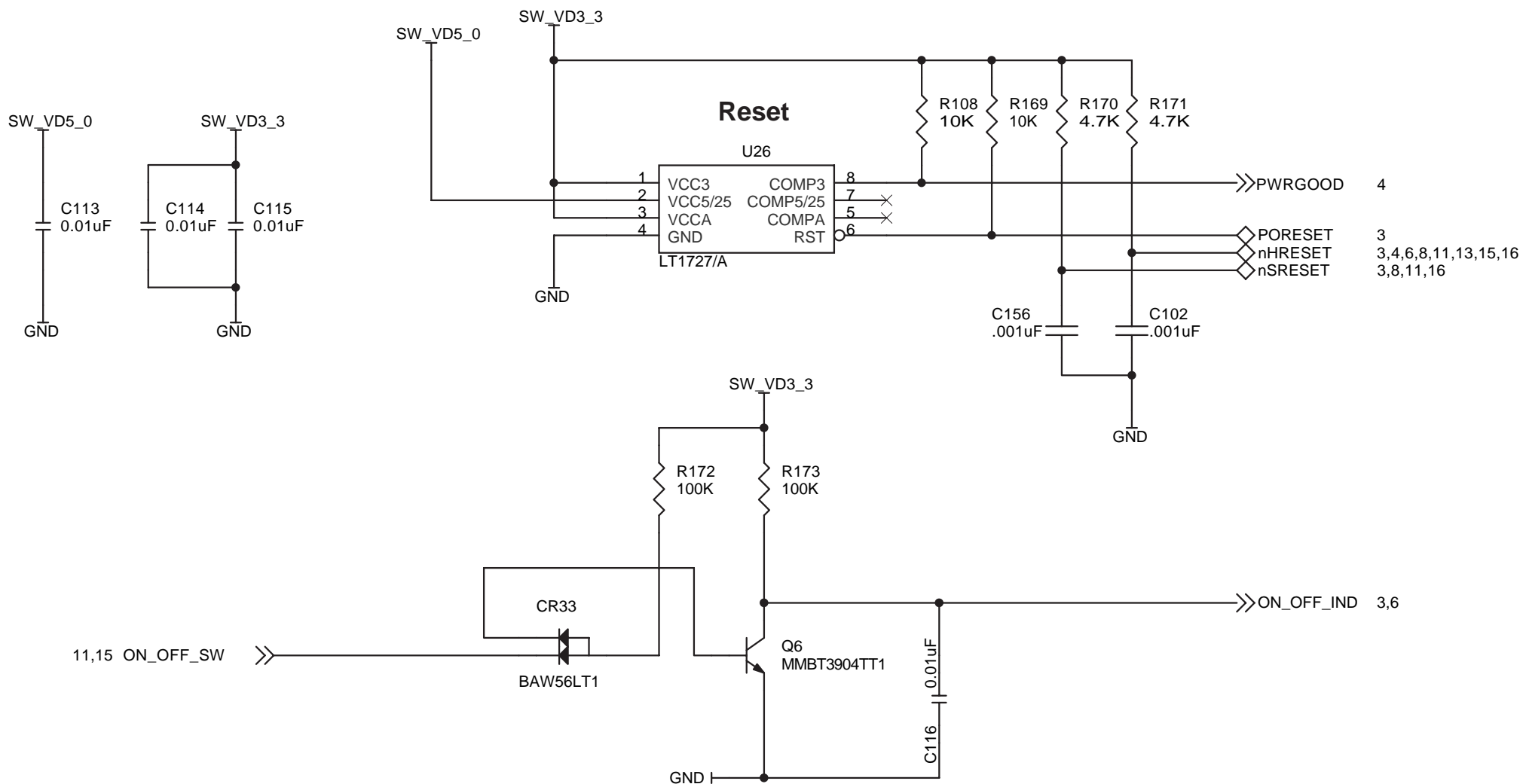
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 10 OF 18)



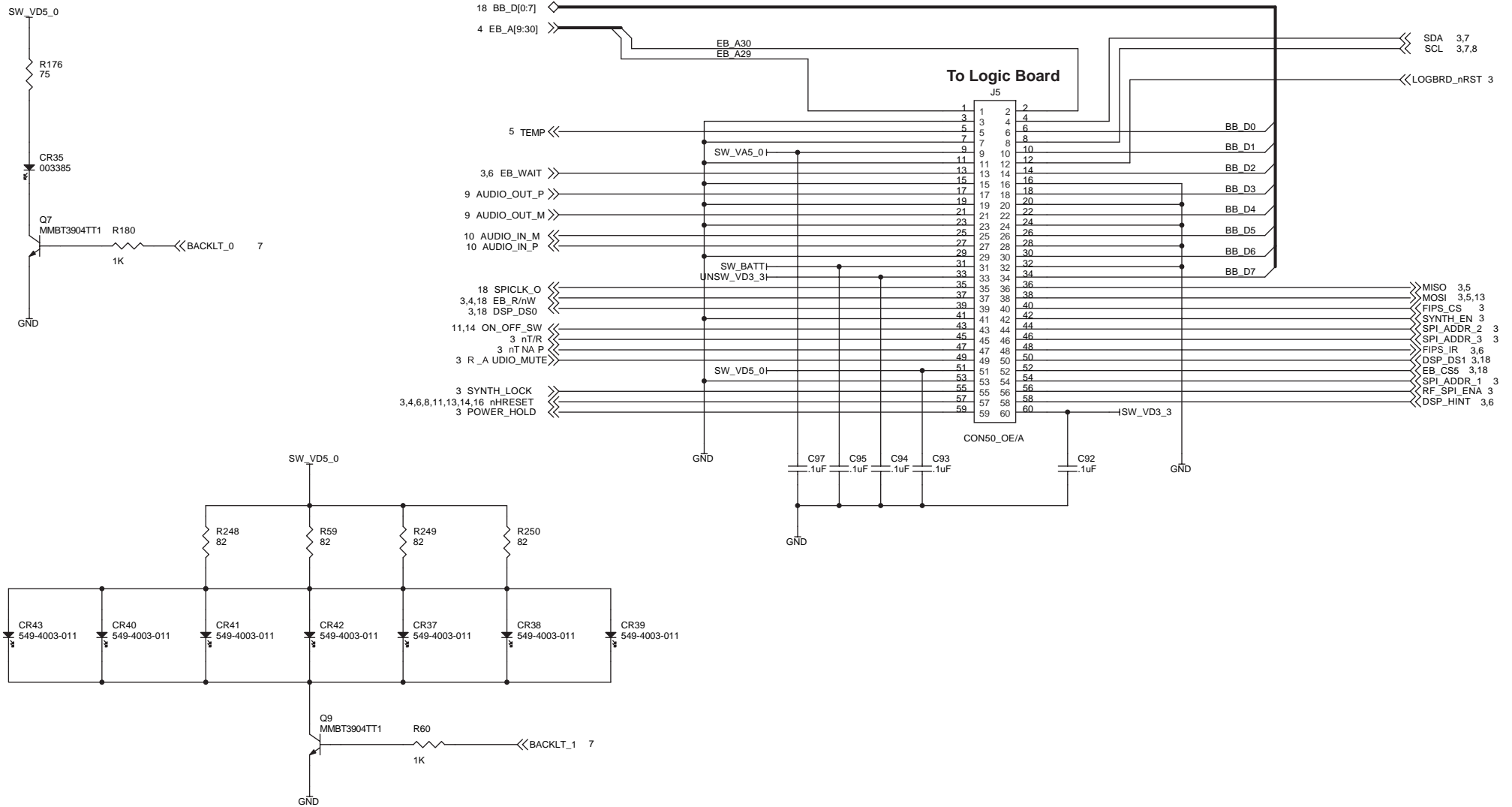
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 12 OF 18)



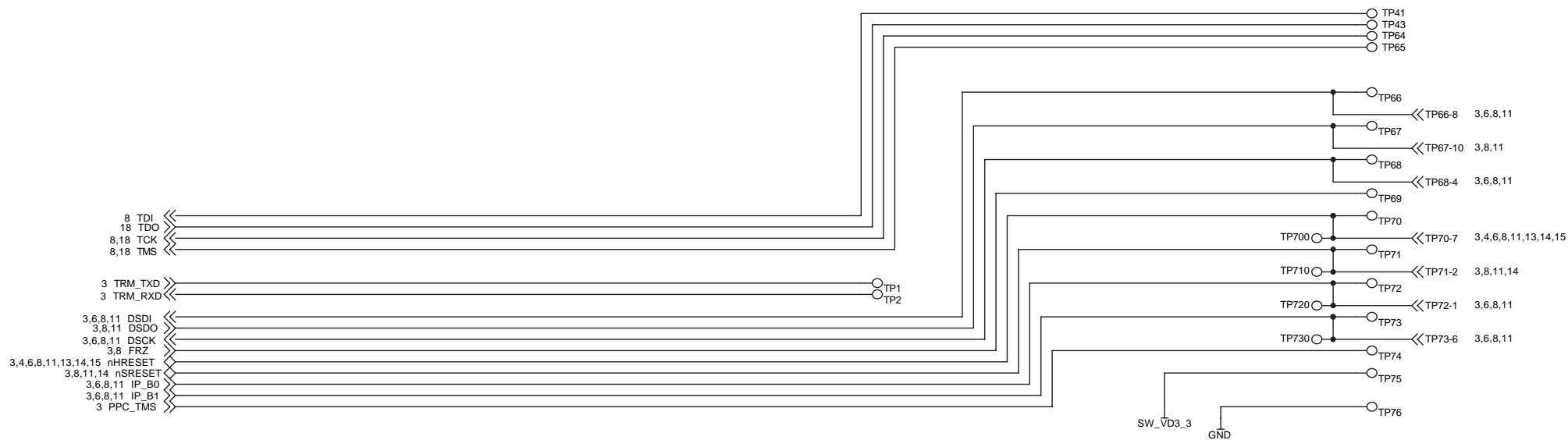
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 13 OF 18)



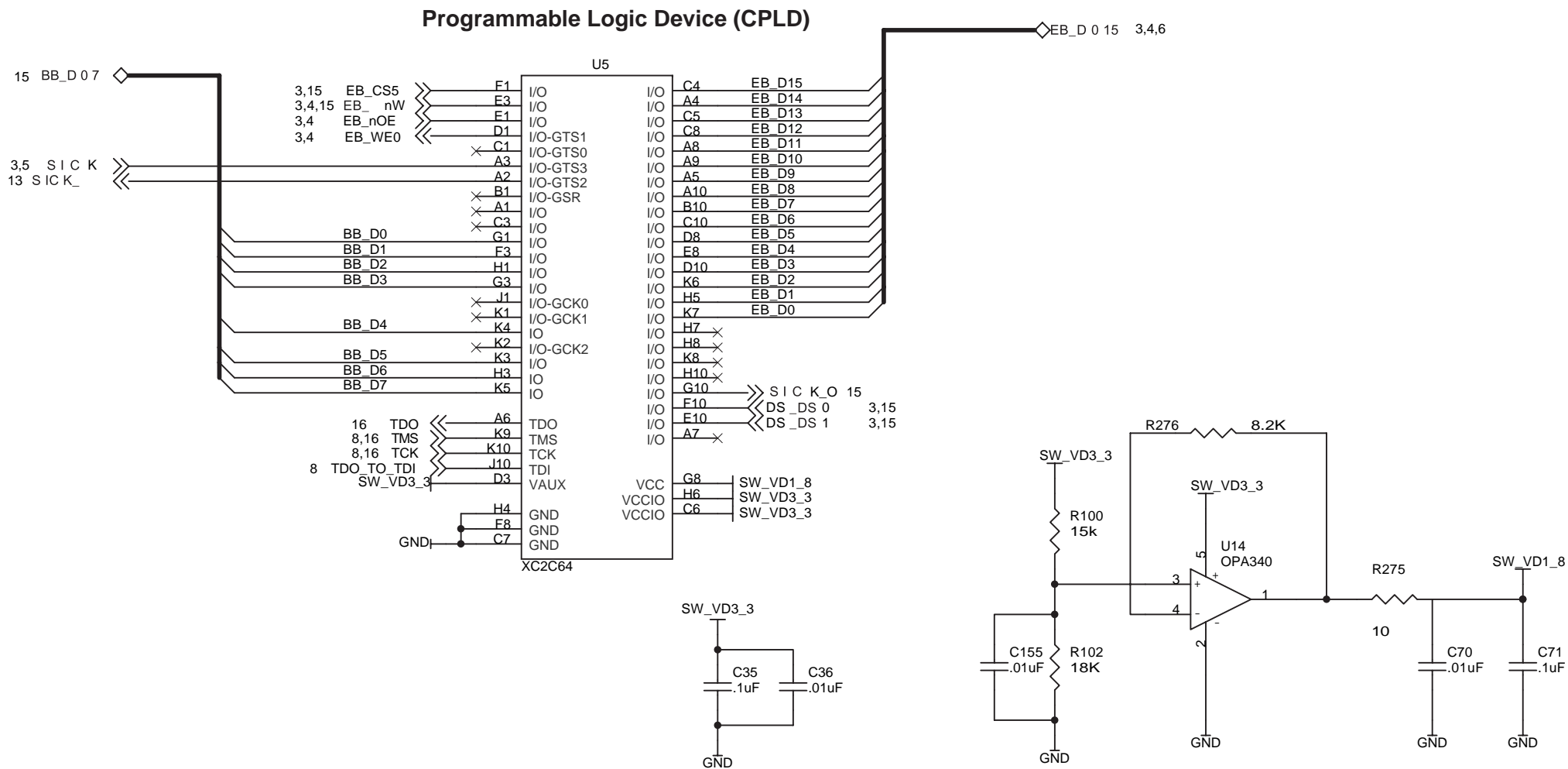
5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 14 OF 18)

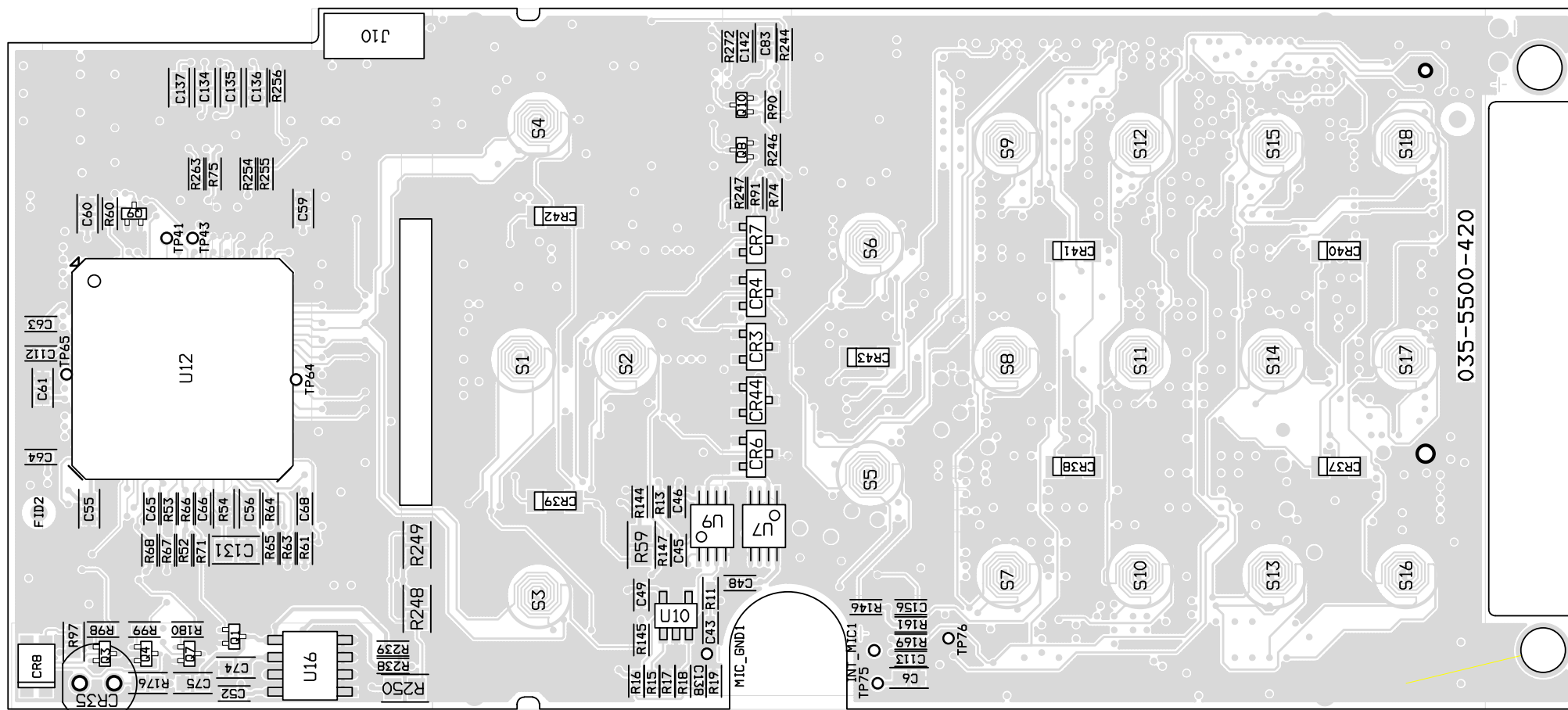


5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 15 OF 18)

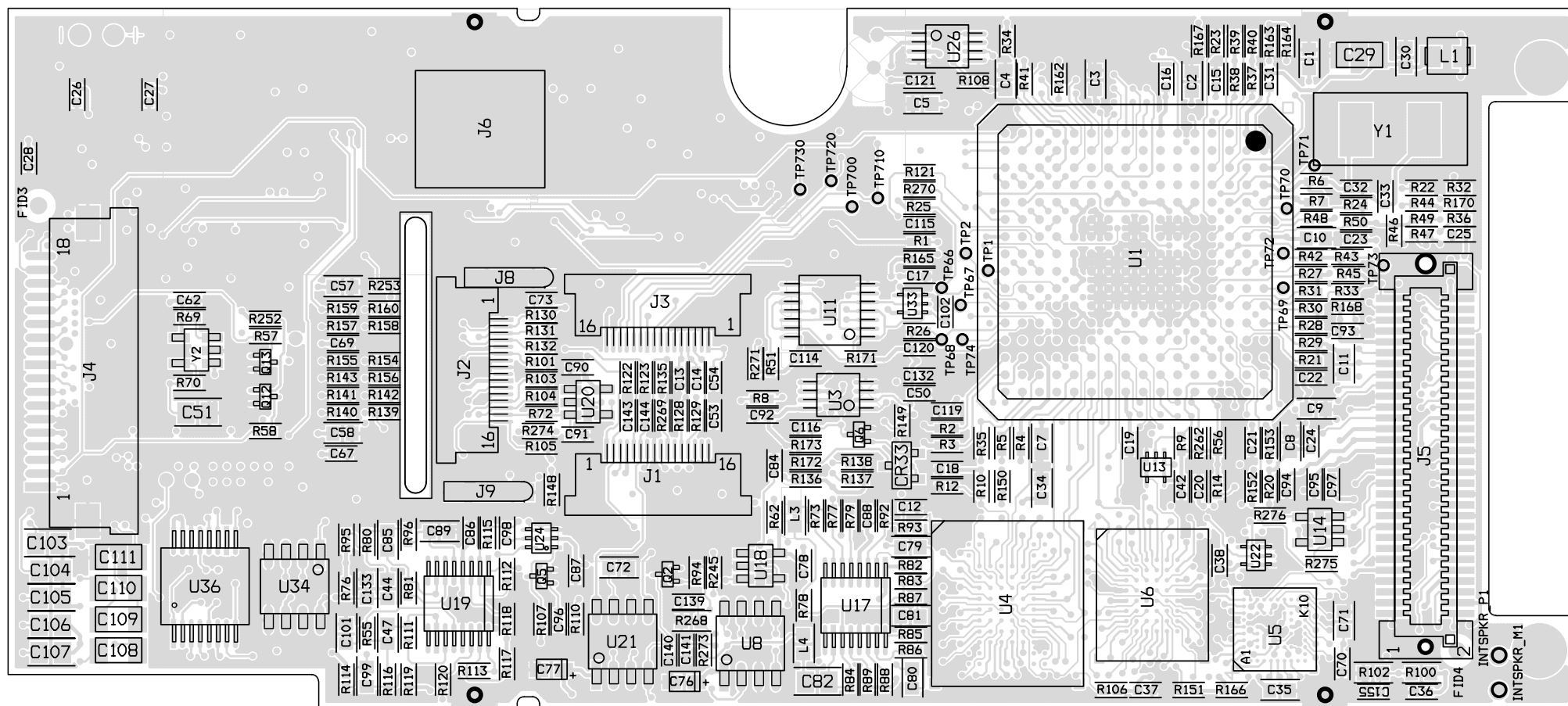


5500-420 USER INTERFACE BOARD VER C SCHEMATIC (PAGE 16 OF 18)

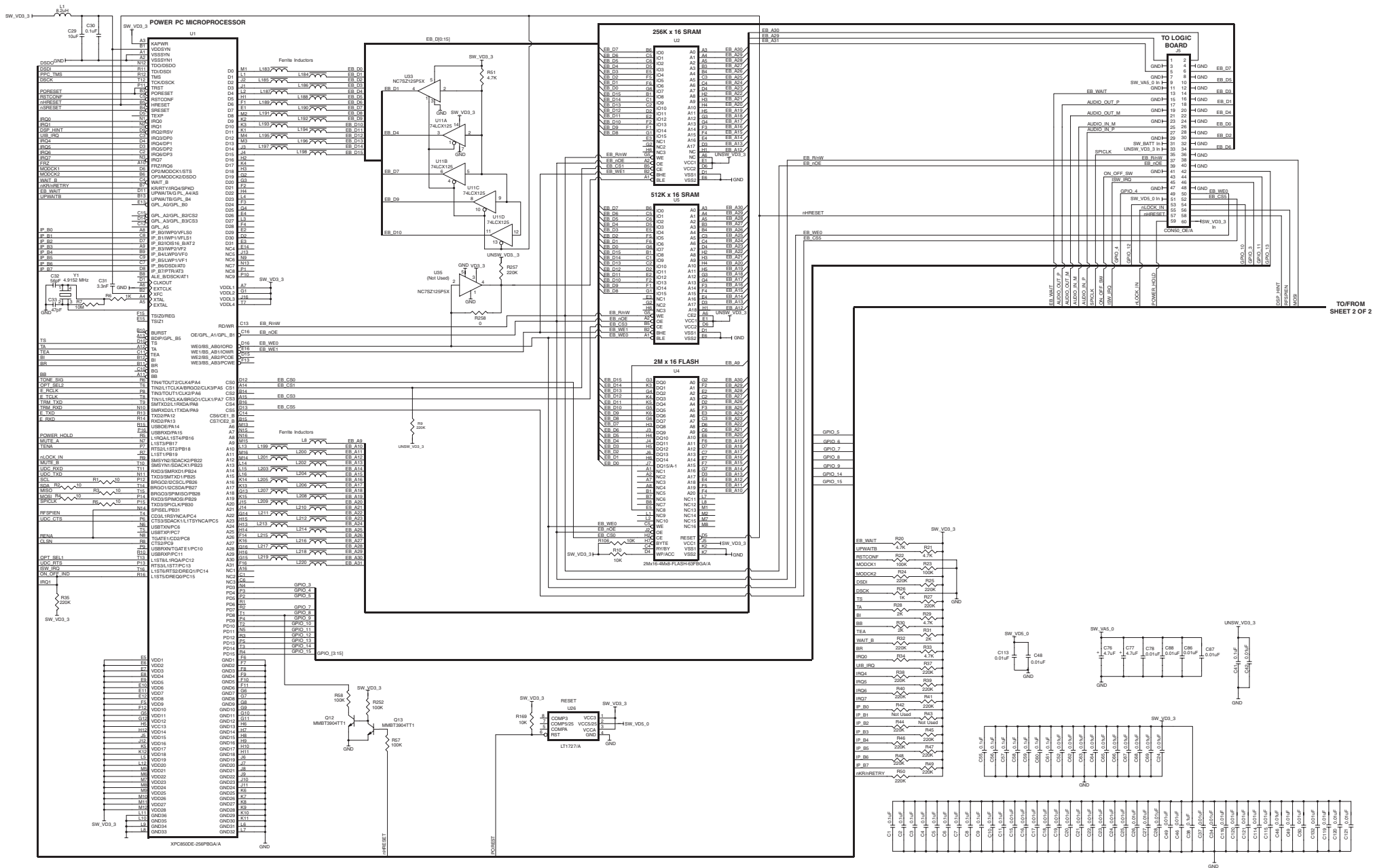




5500-420 USER INTERFACE BOARD VER C TOP VIEW

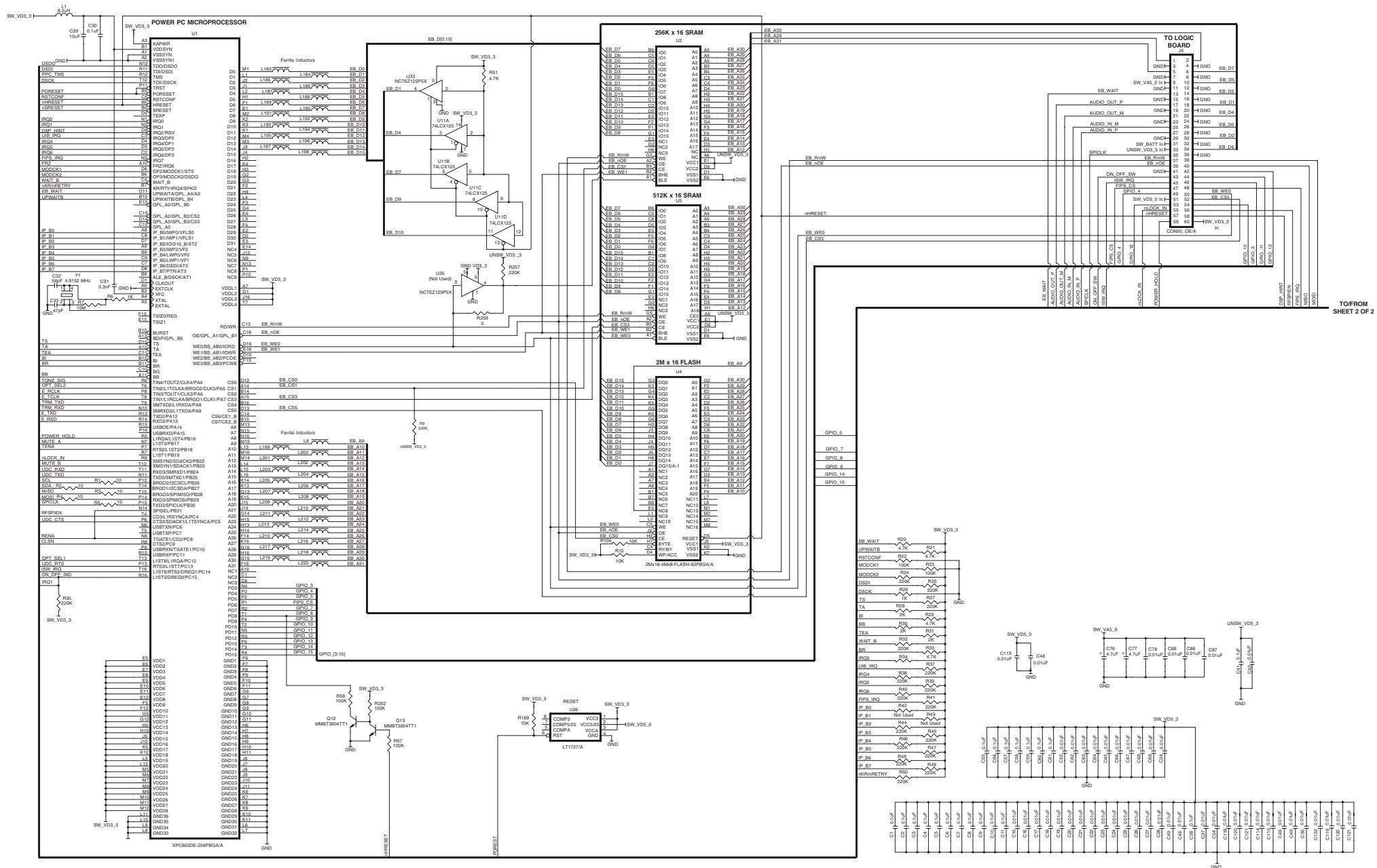


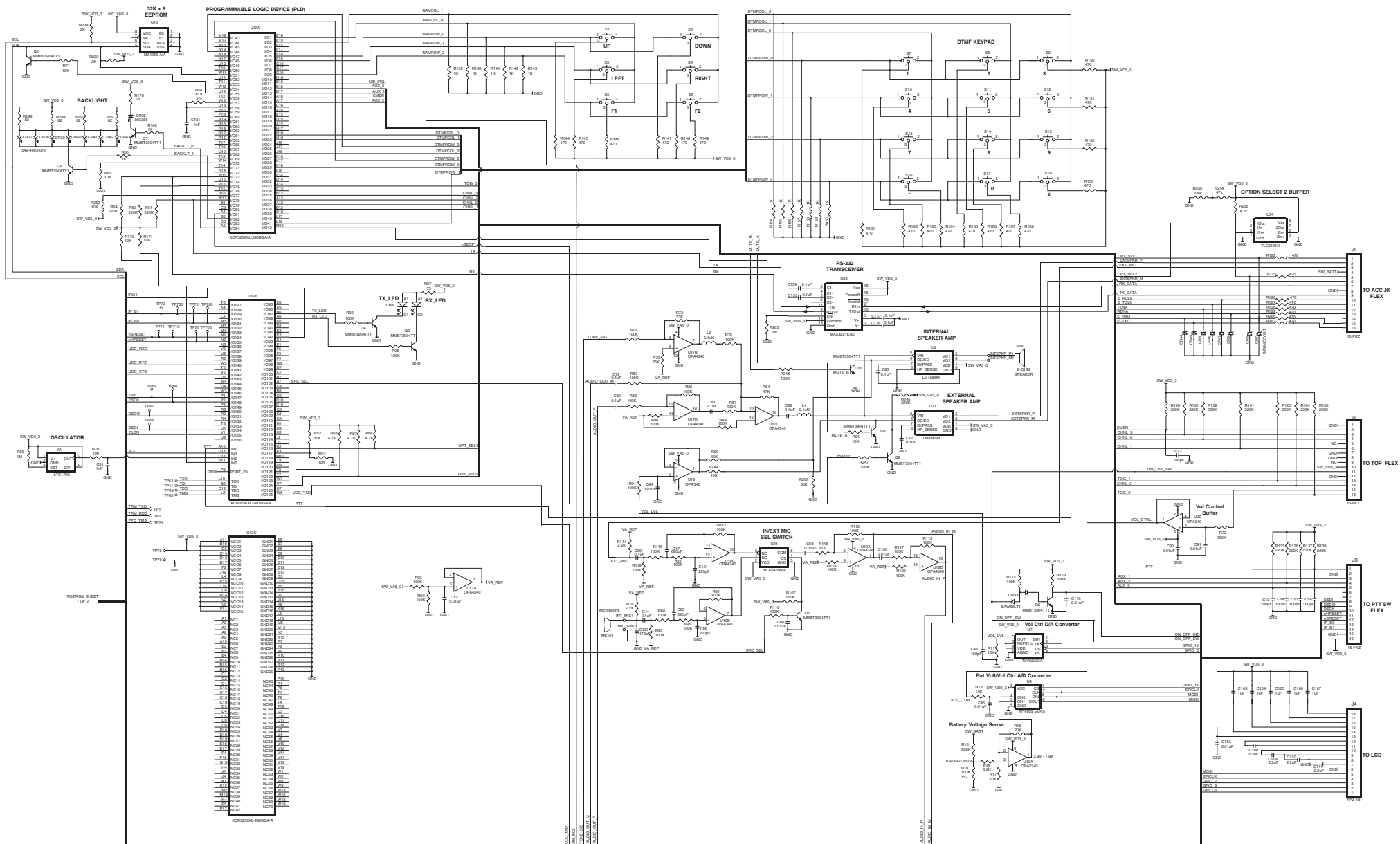
5500-420 USER INTERFACE BOARD VER C BOTTOM VIEW



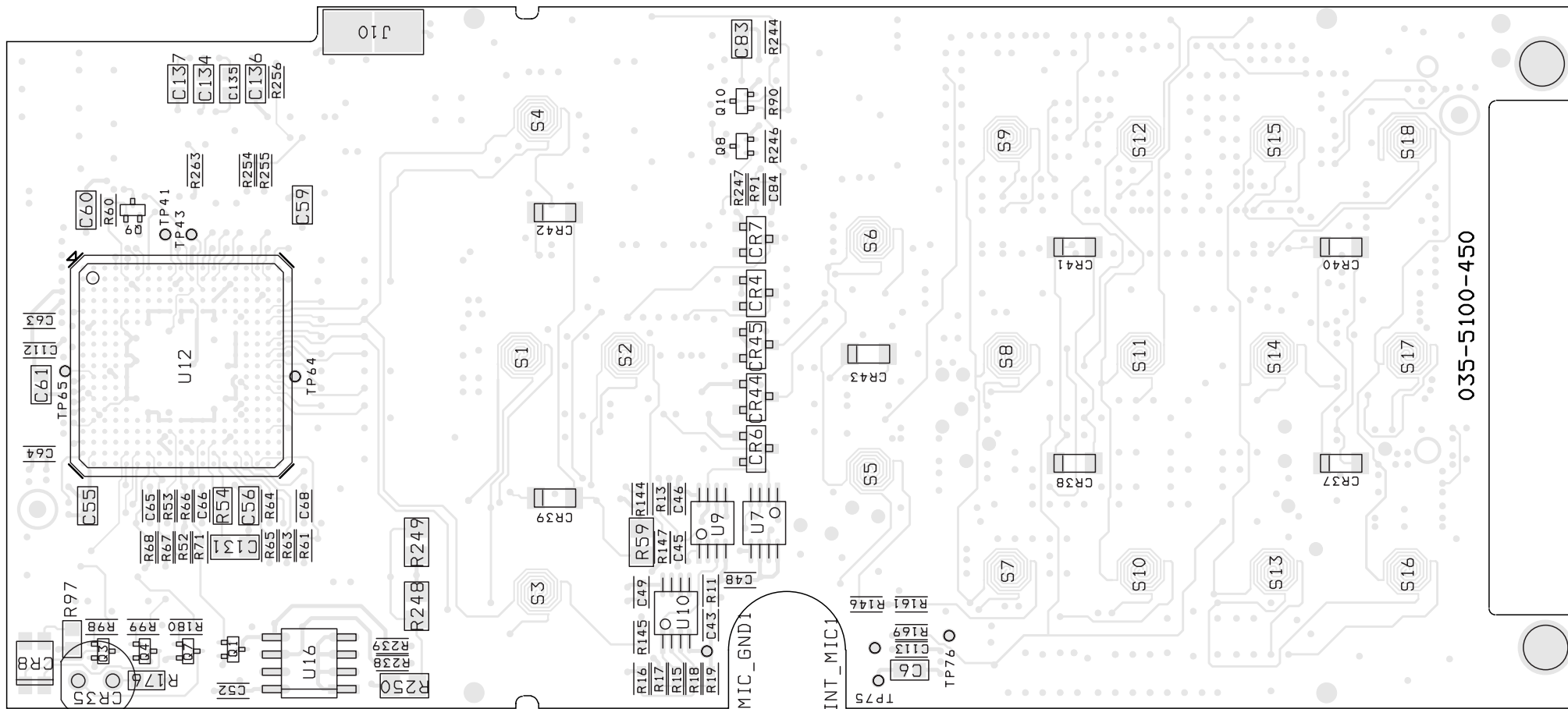
5100-410 USER INTERFACE BOARD VER A SCHEMATIC (PAGE 1 OF 2)



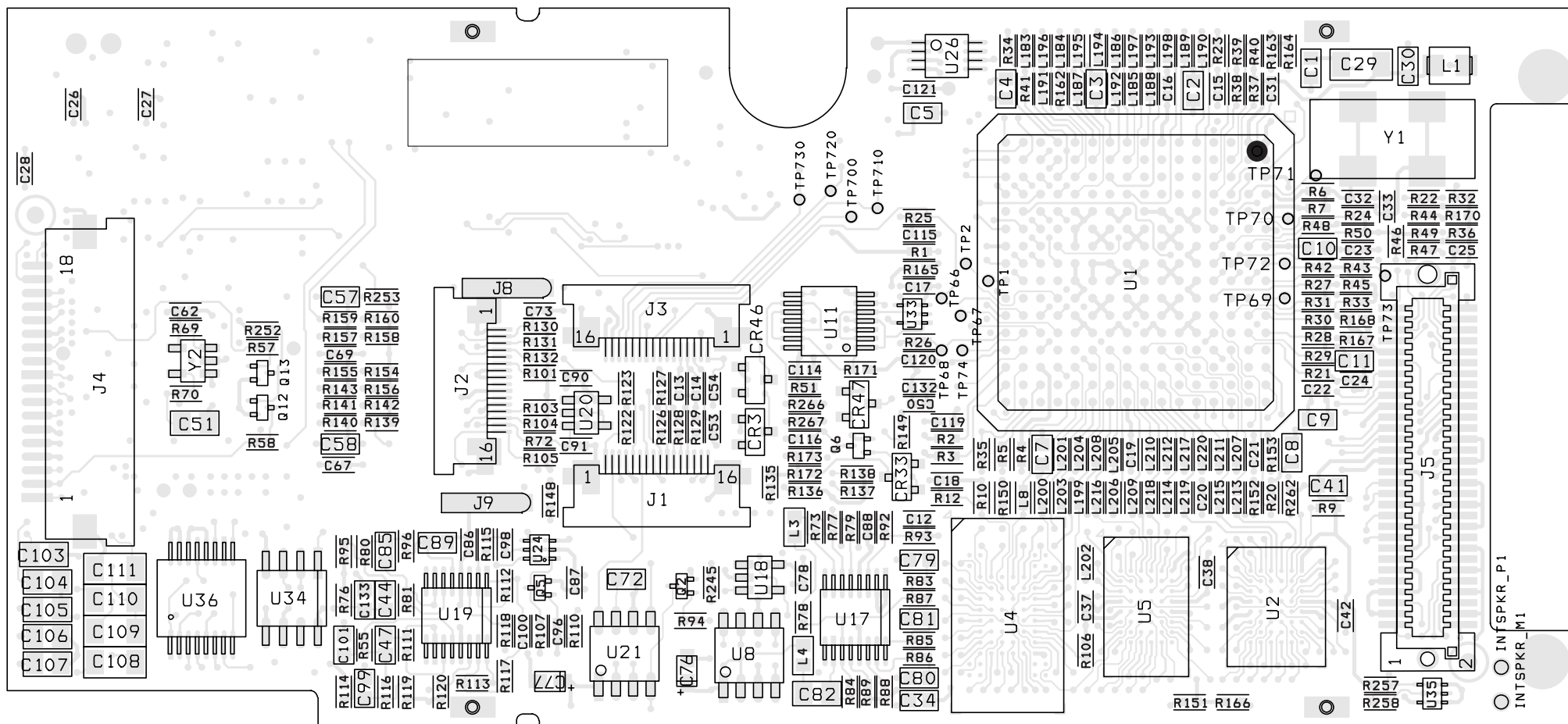




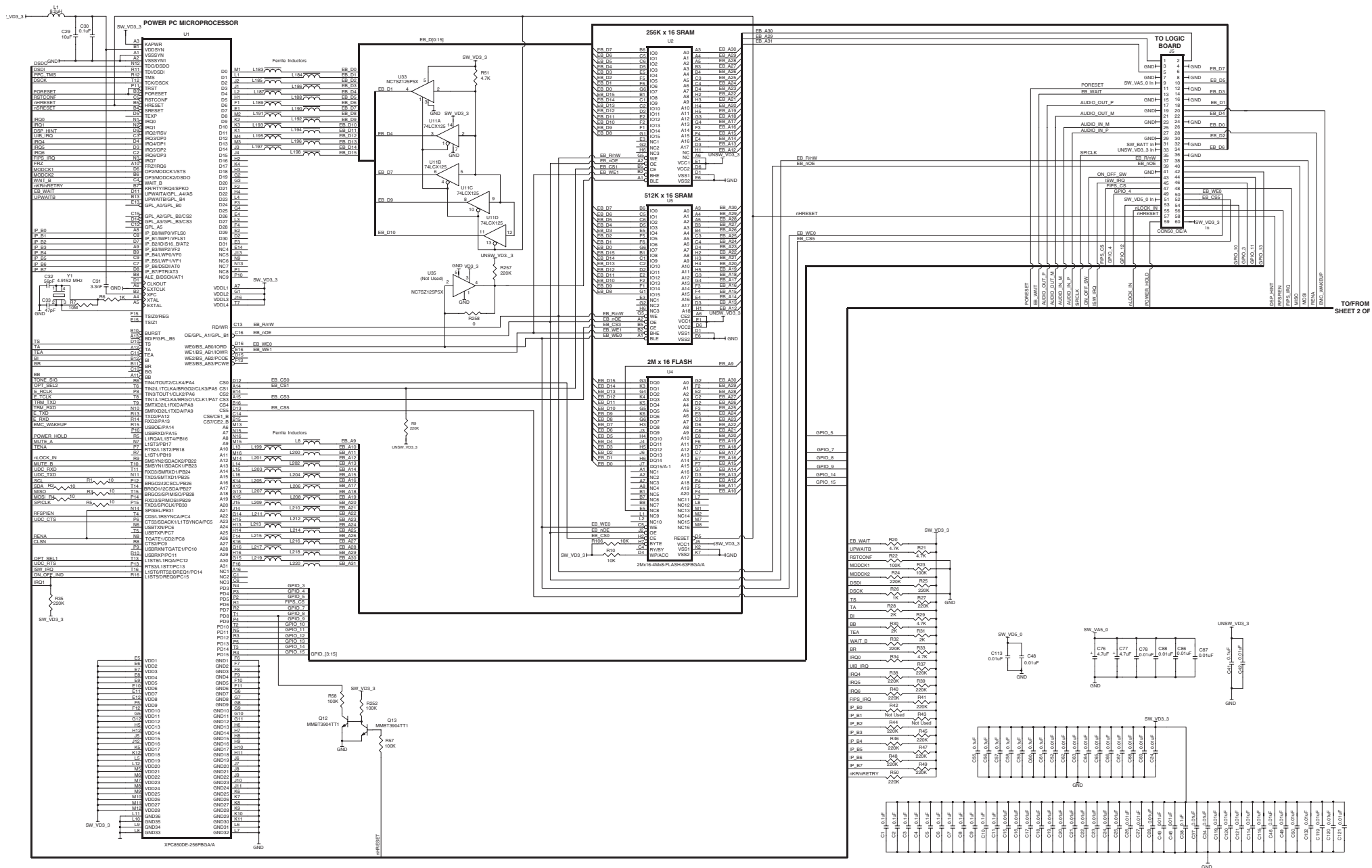
5100-450 USER INTERFACE BOARD VER B SCHEMATIC (PAGE 2 OF 2)



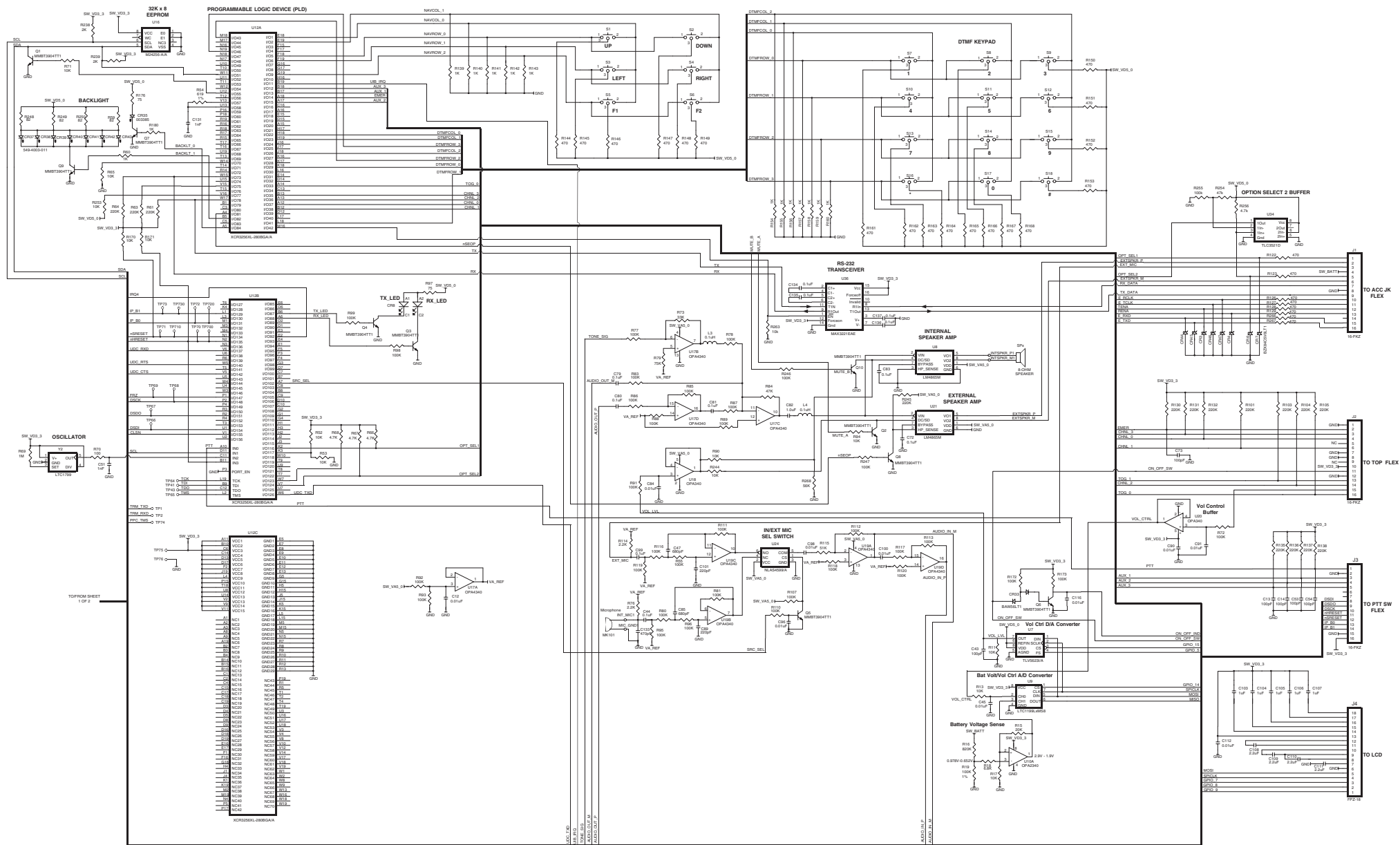
5100-450 USER INTERFACE BOARD VER B TOP VIEW



5100-450 USER INTERFACE BOARD VER B BOTTOM VIEW

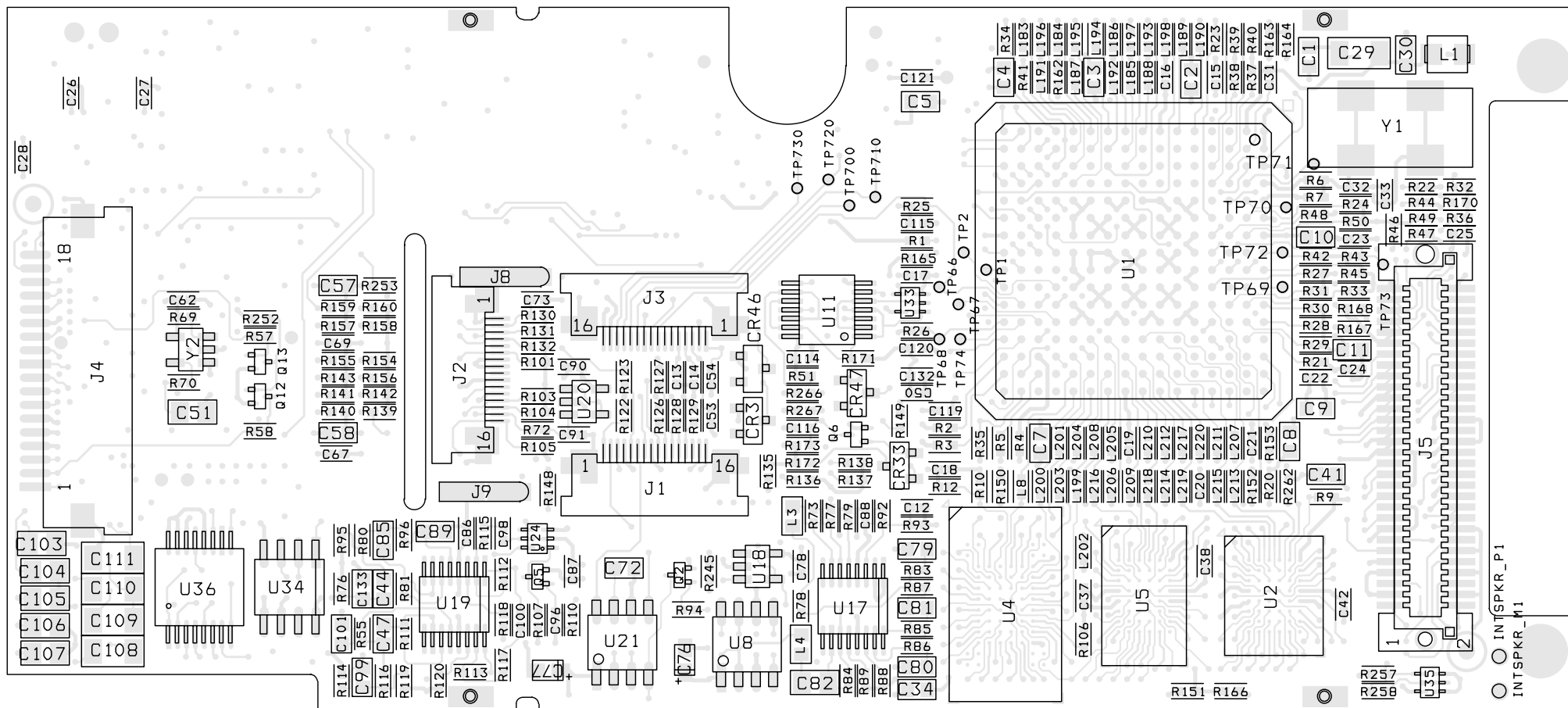


5100-460 USER INTERFACE BOARD VER B SCHEMATIC (PAGE 1 OF 2)

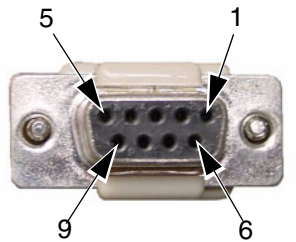


5100-460 USER INTERFACE BOARD VER B SCHEMATIC (PAGE 2 OF 2)

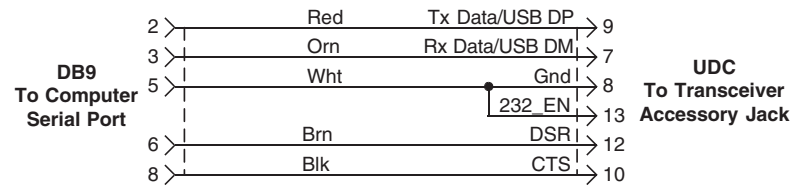




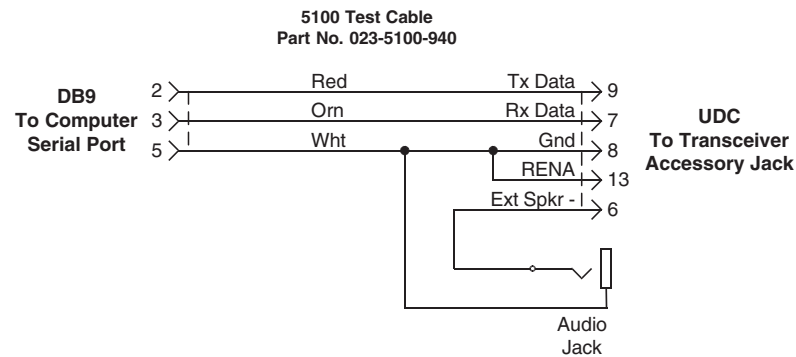
5100-460 USER INTERFACE BOARD VER B BOTTOM VIEW



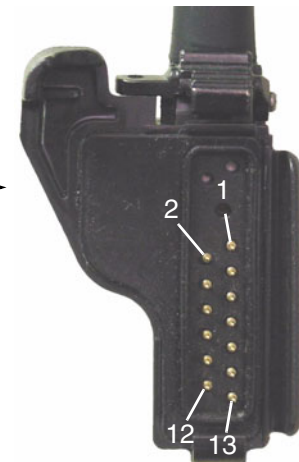
DB9 F Pin Numbering



PROGRAMMING CABLE SCHEMATIC Part No. 023-5100-920

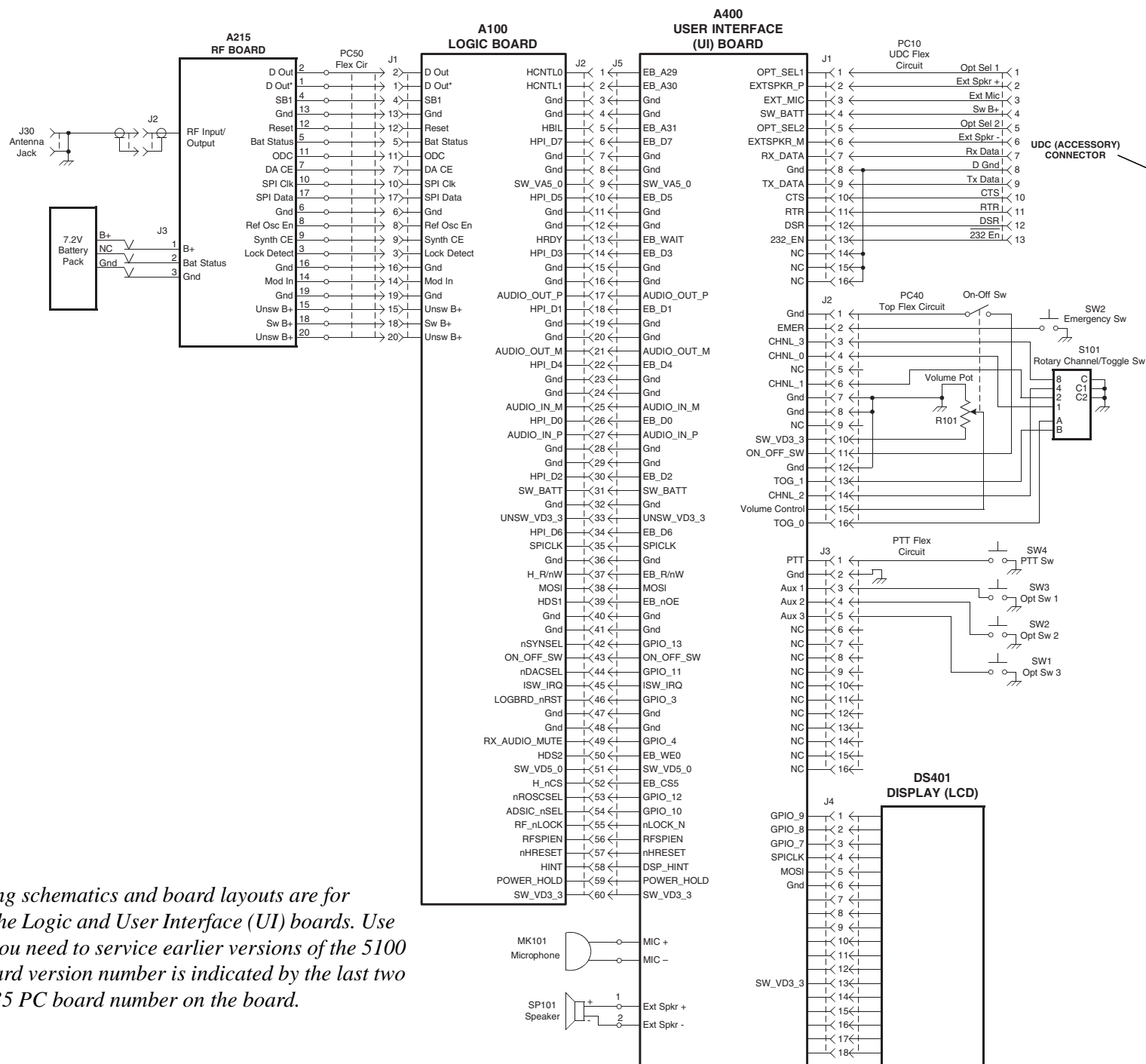


TEST CABLE SCHEMATIC Part No. 023-5100-940

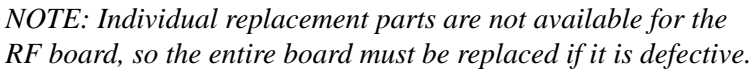


UDC Pin Numbering

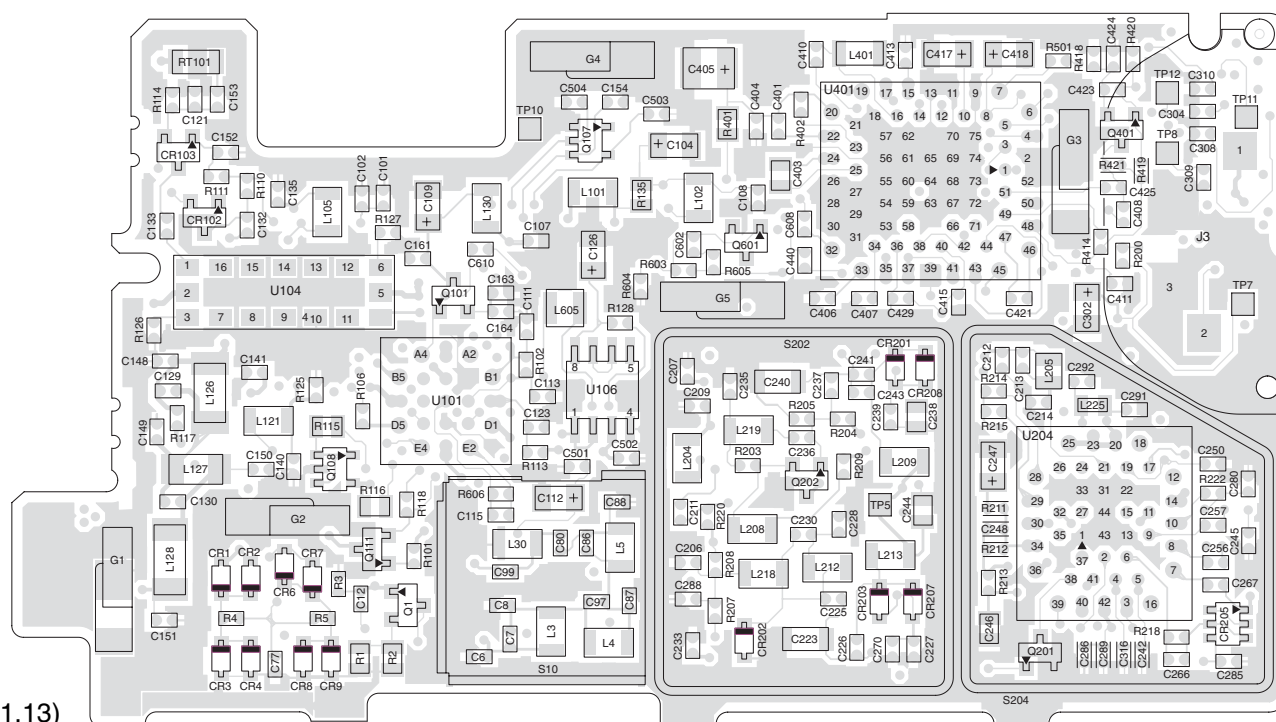
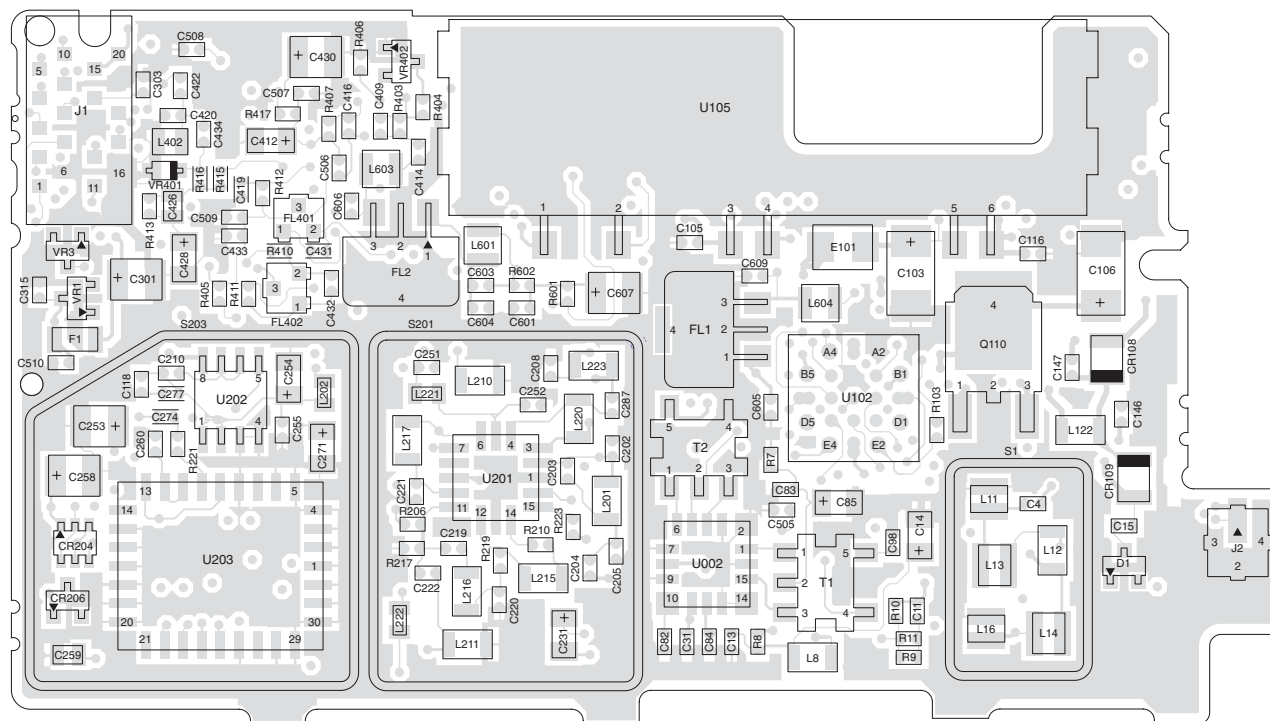
SECTION 9 OBSOLETE BOARD SCHEMATICS AND LAYOUTS



NOTE: The following schematics and board layouts are for earlier versions of the Logic and User Interface (UI) boards. Use this information if you need to service earlier versions of the 5100 transceiver. The board version number is indicated by the last two digits (.xx) of the 035 PC board number on the board.

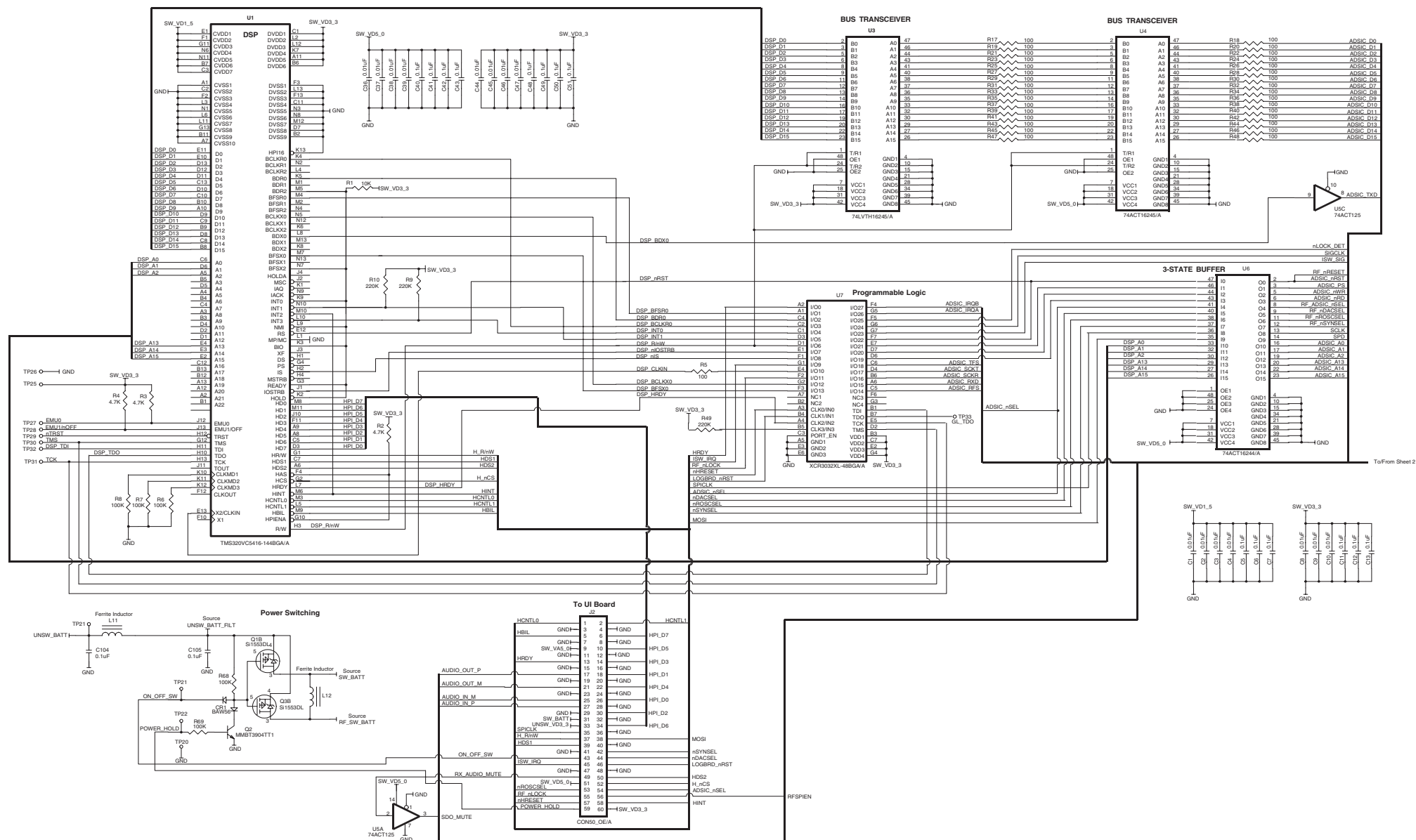


VHF RF BOARD VER A SCHEMATIC (PART 1 OF 3)



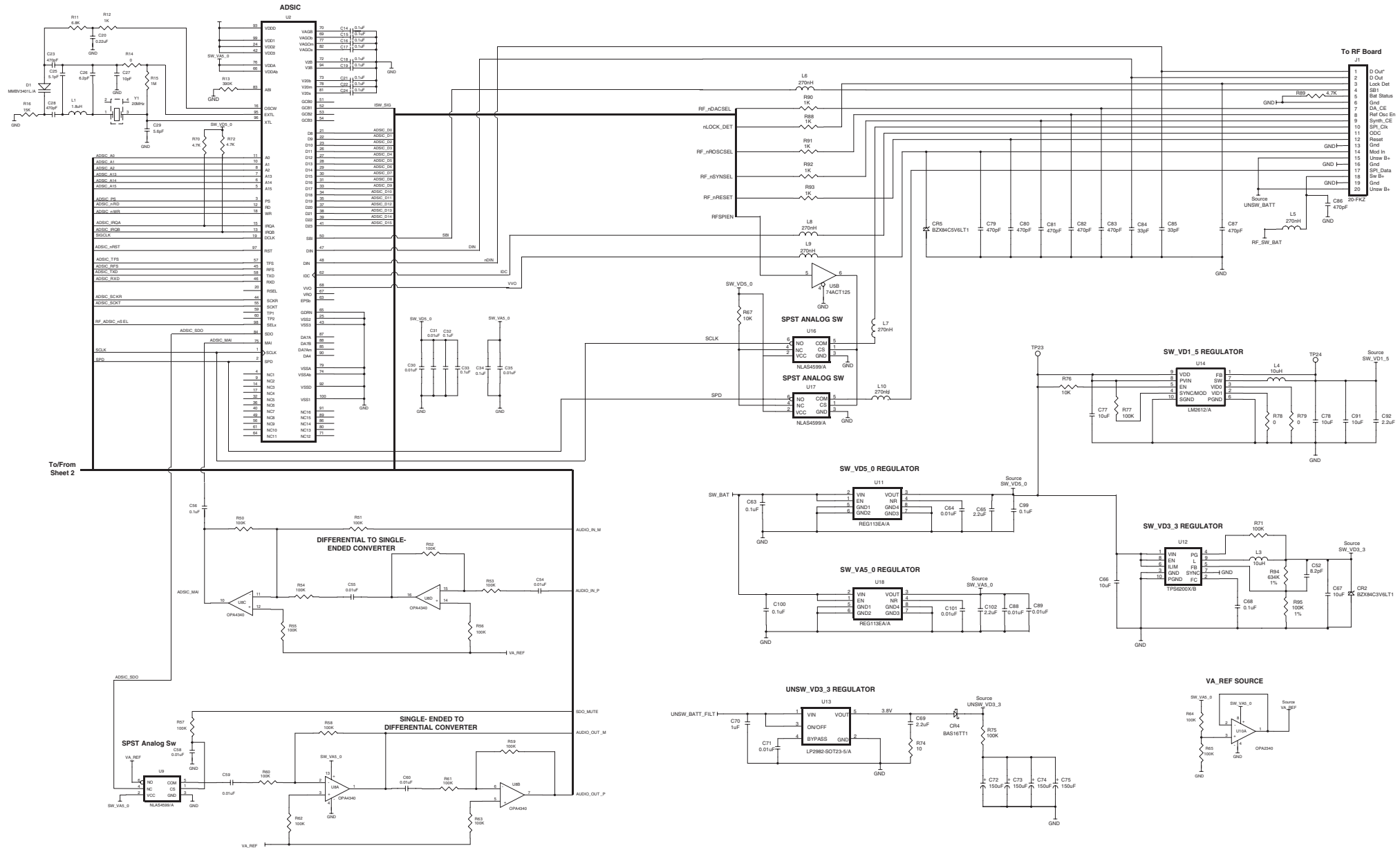
Version A Board (see Section 1.13)

OBSOLETE VERSION



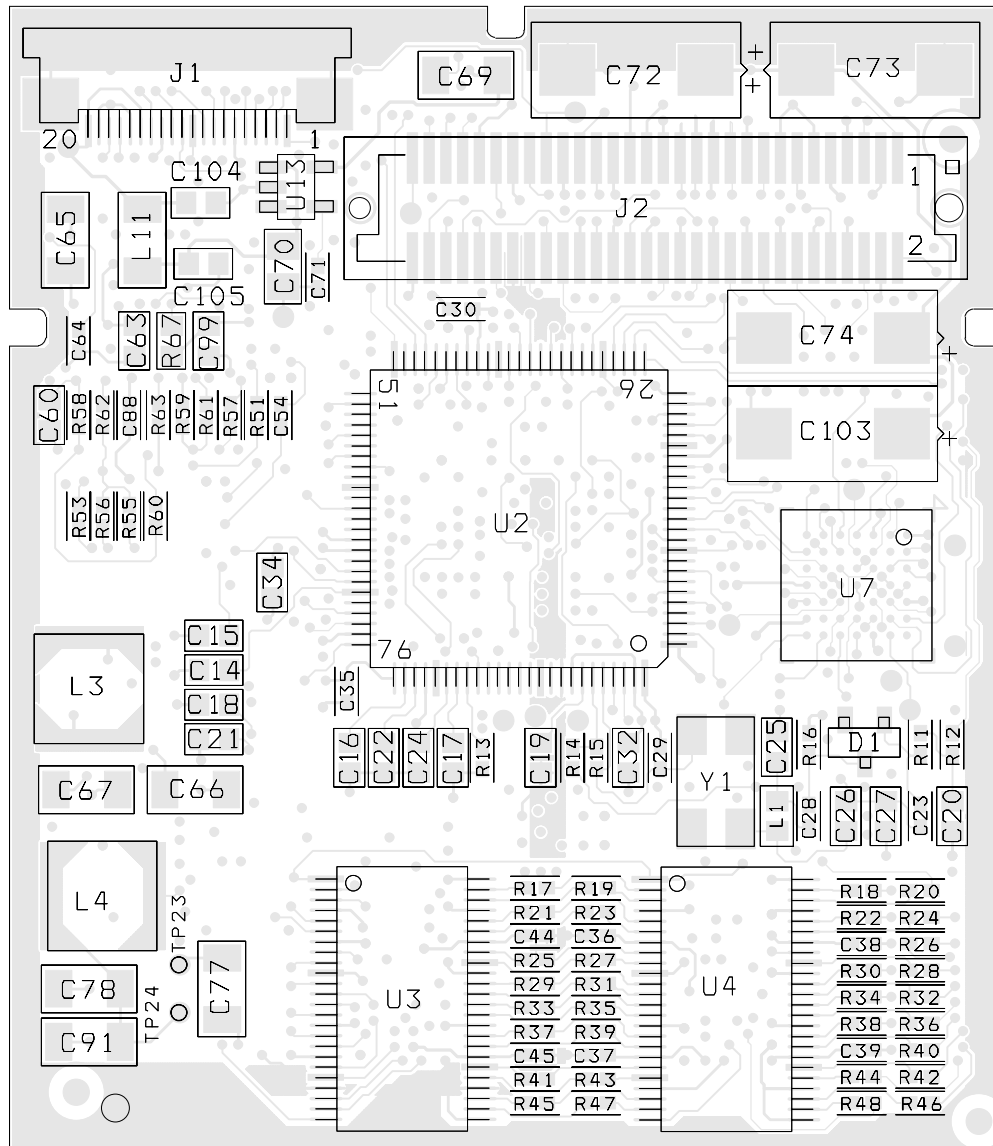
5100-110 LOGIC BOARD VER A SCHEMATIC (PART 1 OF 2)

OBSOLETE VERSION



5100-110 LOGIC BOARD VER A SCHEMATIC (PART 2 OF 2)

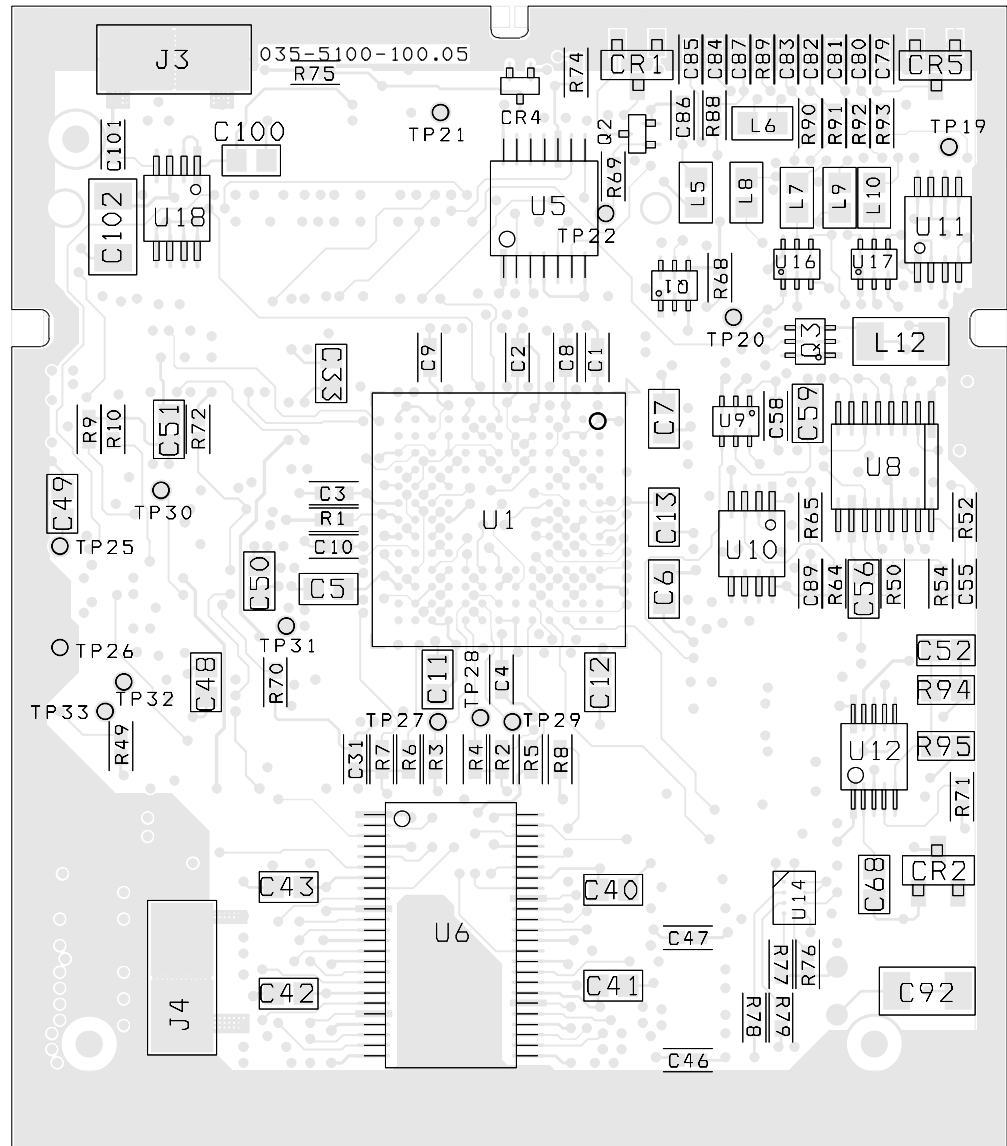
OBSOLETE VERSION



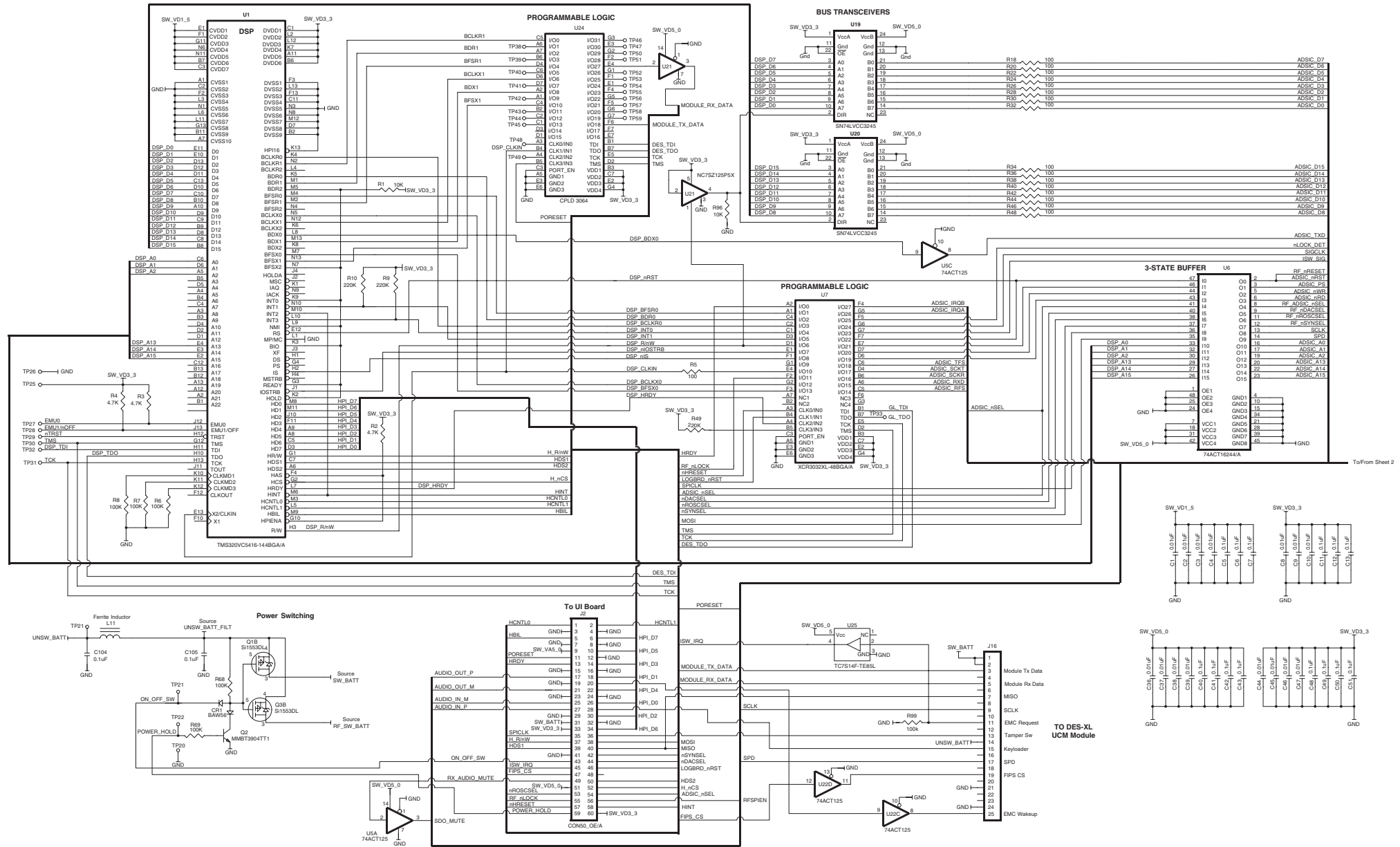
5100-110 LOGIC BOARD VER A TOP VIEW

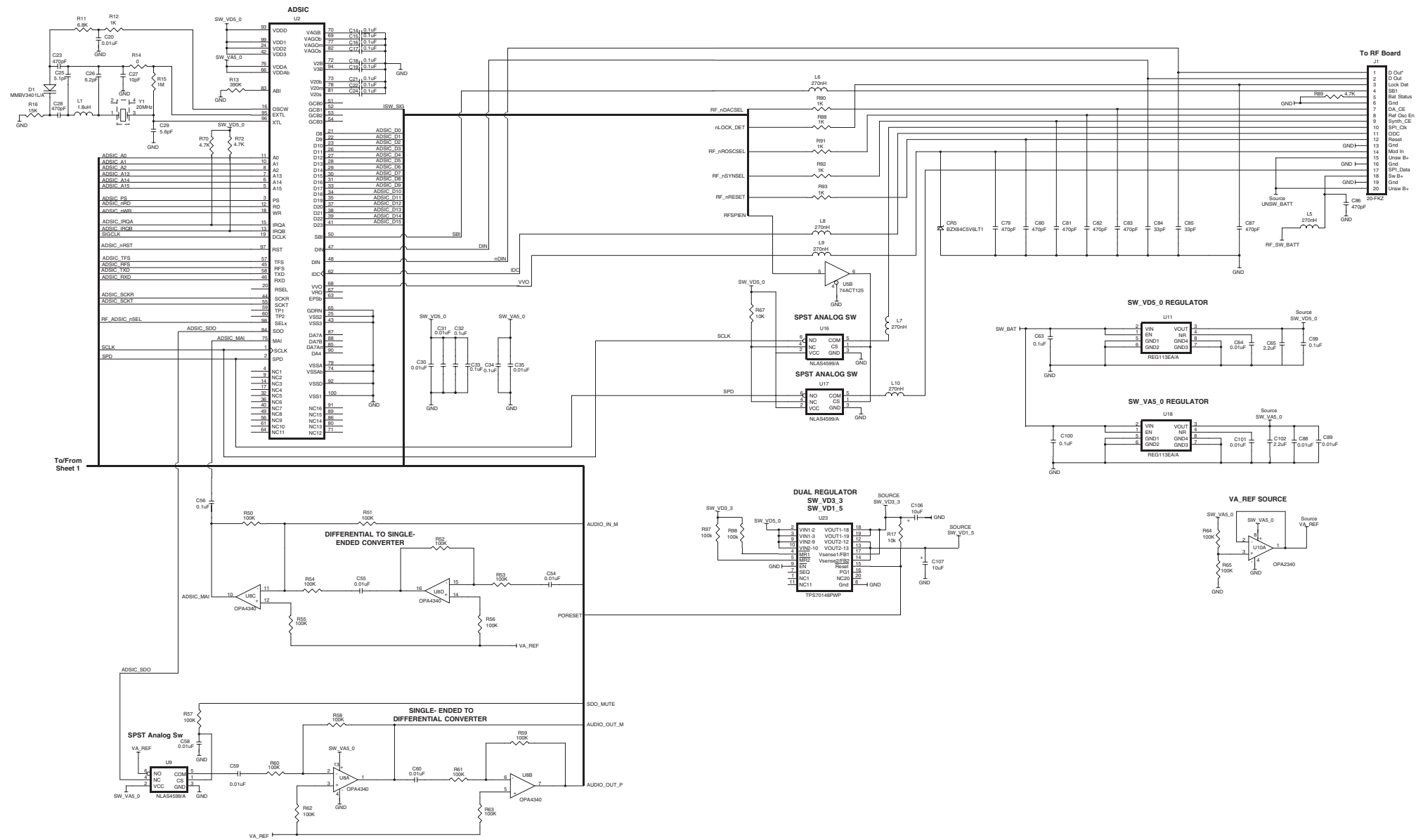
Version A Board (see Section 1.13)

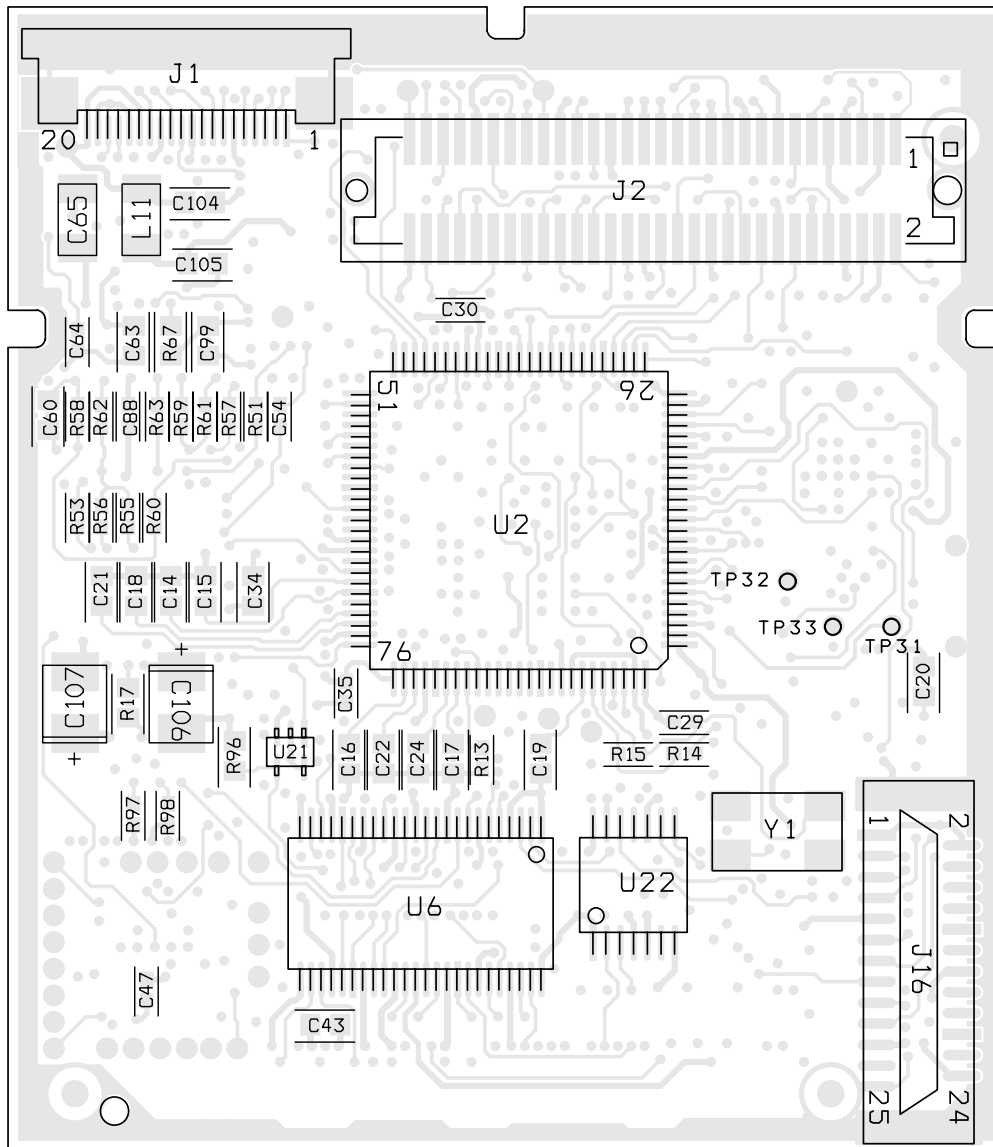
OBSOLETE VERSION



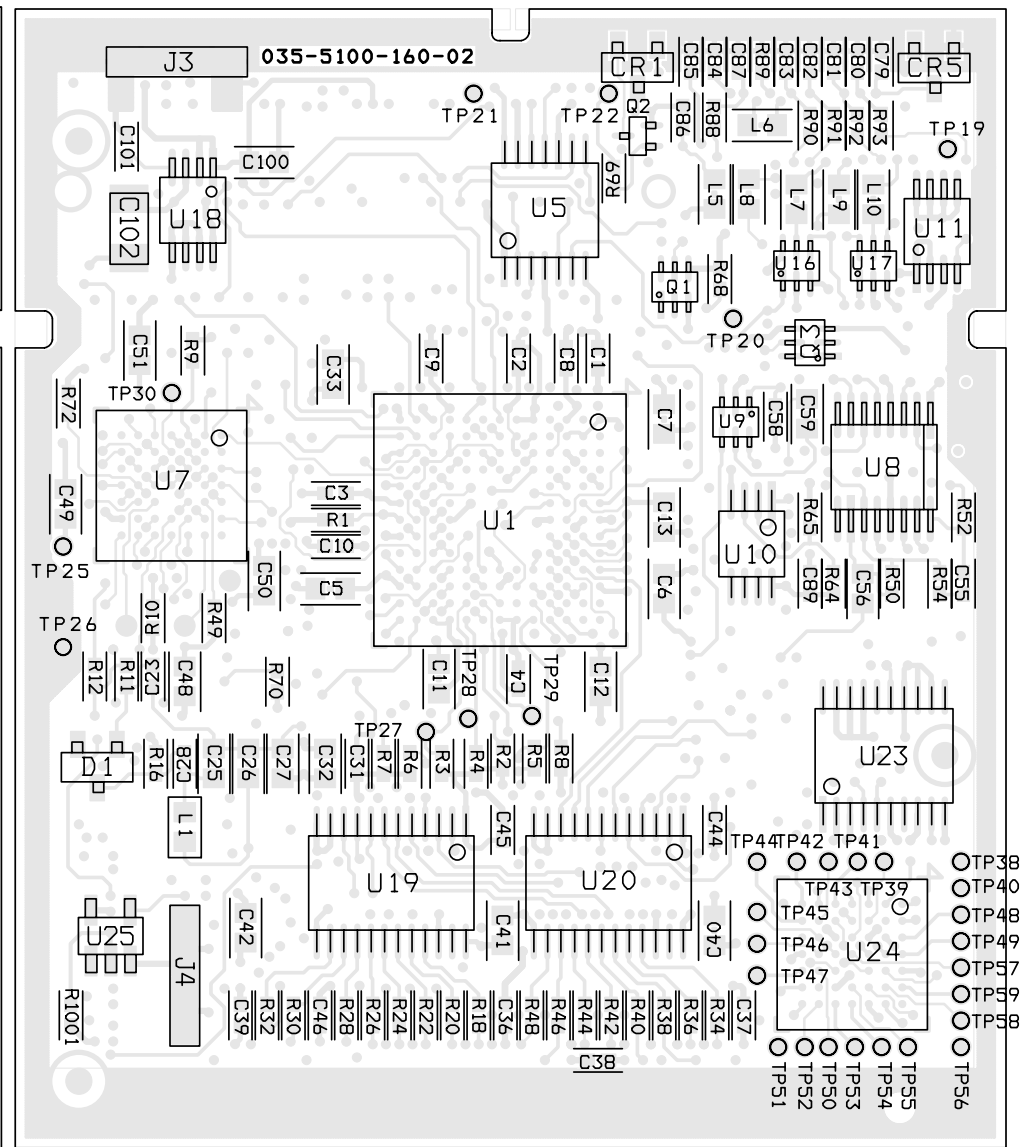
5100-110 LOGIC BOARD VER A BOTTOM VIEW







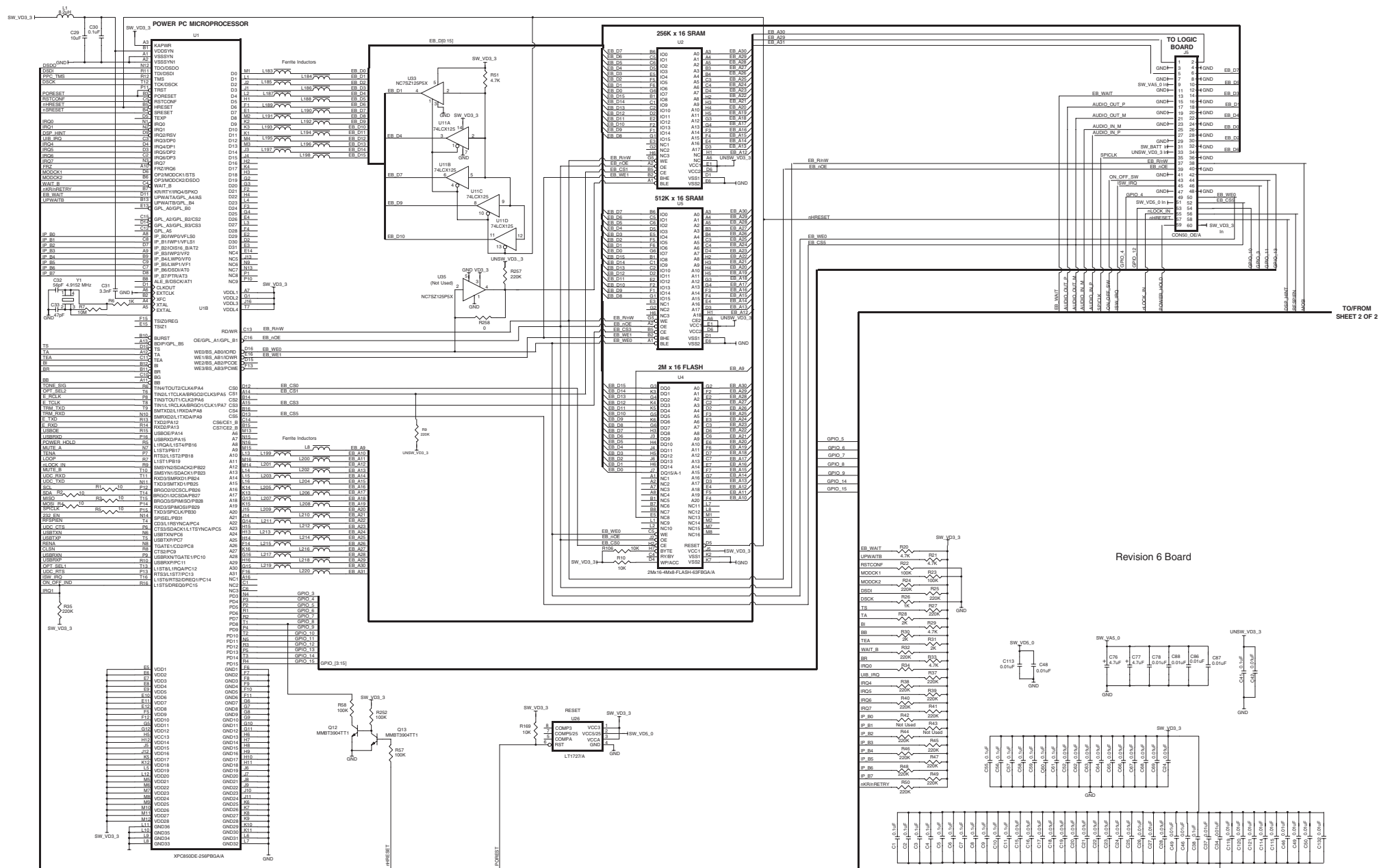
5100-160 LOGIC BOARD VER B TOP VIEW



5100-160 LOGIC BOARD VER B BOTTOM VIEW

Version B Board (see Section 1.13)

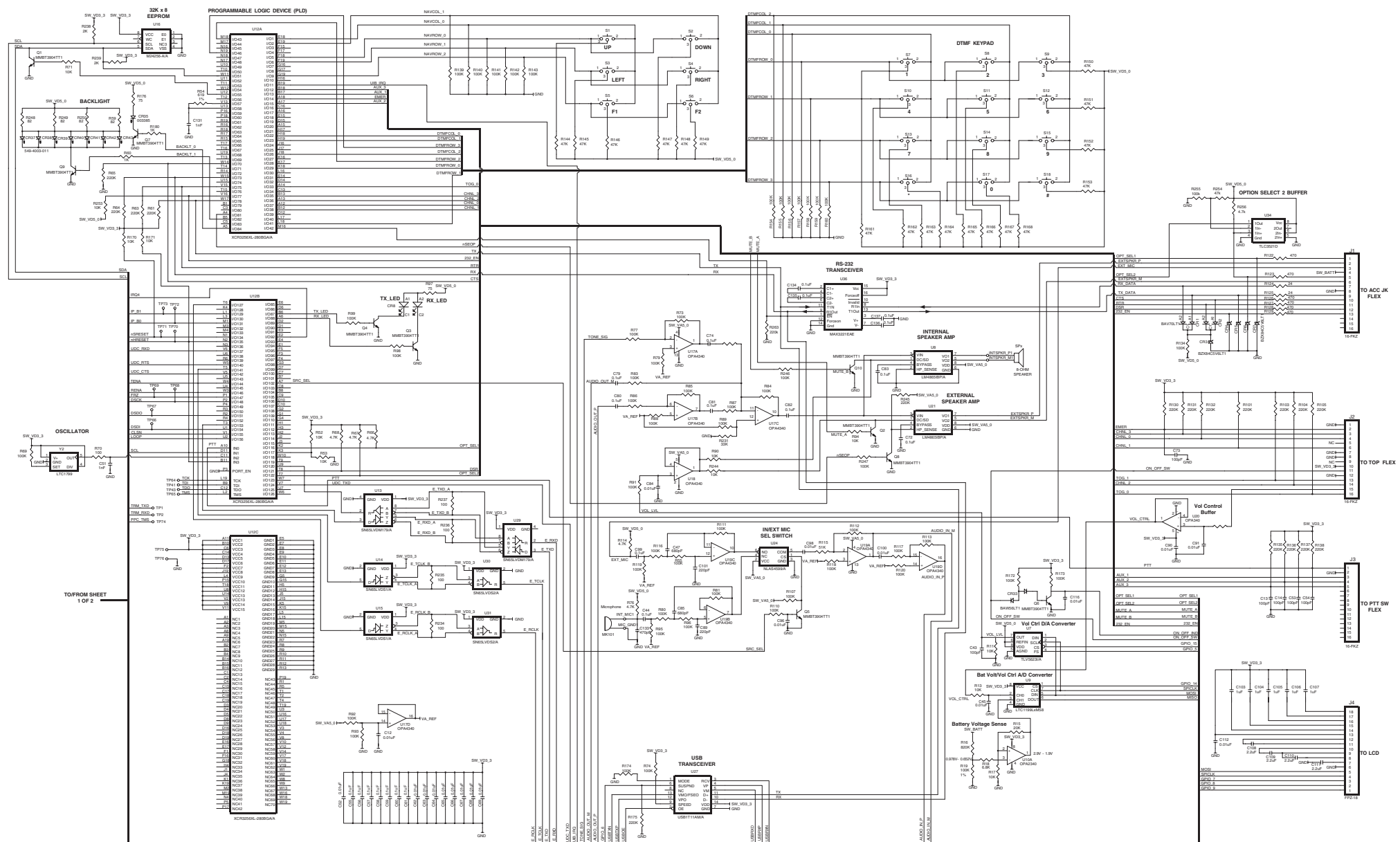
OBSOLETE VERSION



Version A Board (see Section 1.13)

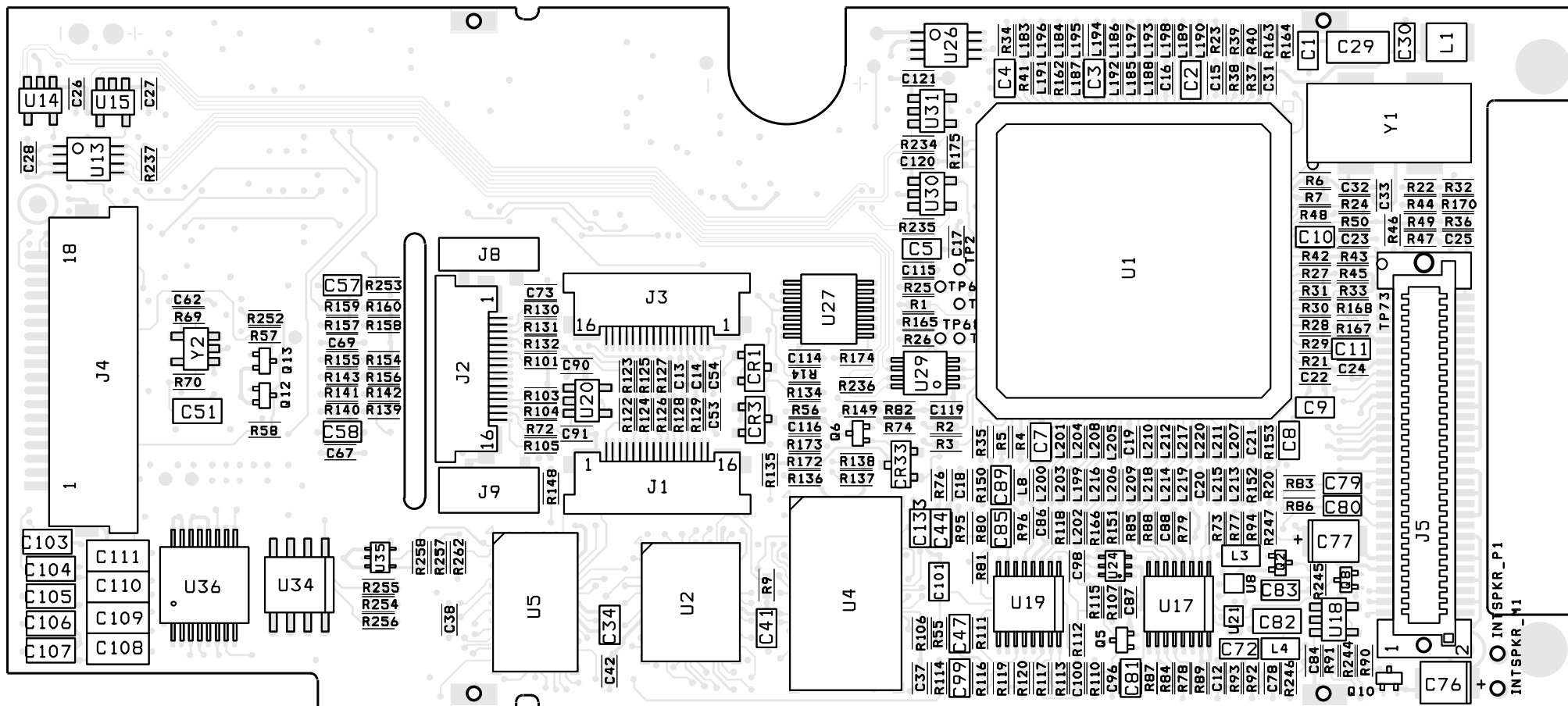
5100-410 USER INTERFACE BOARD VER A SCHEMATIC (PART 1 OF 2)

OBSELETE VERSION



5100-410 USER INTERFACE BOARD VER A SCHEMATIC (PART 2 OF 2)

OBSOLETE VERSION



5100-410 USER INTERFACE BOARD VER A TOP VIEW

Version A Board (see Section 1.13)

OBSOLETE VERSION



